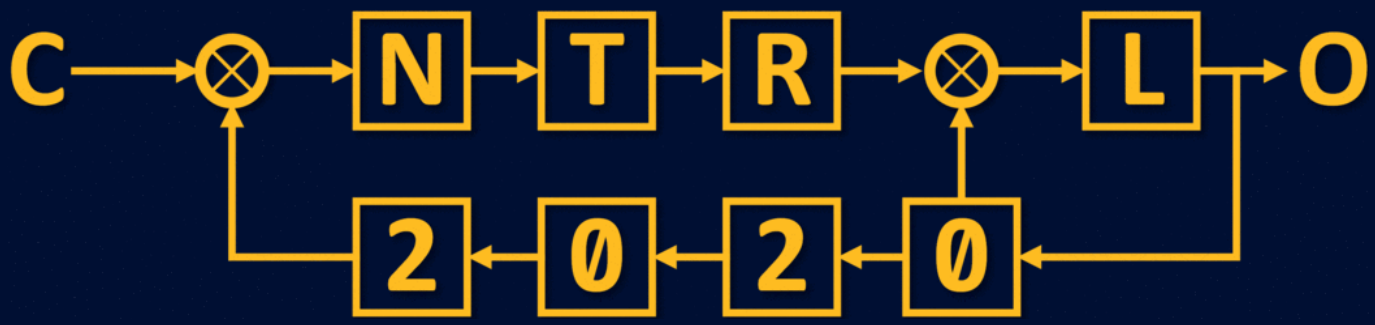

14th International Conference on Automatic Control and Soft Computing

Bragança, Portugal | July 01-03, 2020

Organization

Associação Portuguesa de Controlo Automático

INSTITUTO POLITÉCNICO DE BRAGANÇA
Escola Superior de Tecnologia e Gestão

UNIVERSIDADE DE TRÁS-OS-MONTES E ALTO DOURO

14^{th} International Conference on Automatic Control and Soft-Computing

CONTROLO'2020

BOOK OF ABSTRACTS

Instituto Politécnico de Bragança
July 1-3, 2020

Editors

José Alexandre de Carvalho Gonçalves
Instituto Politécnico de Bragança
Campus de Santa Apolónia
5300-253 Bragança - Portugal

Manuel Teixeira Braz César
Instituto Politécnico de Bragança
Campus de Santa Apolónia
5300-253 Bragança - Portugal

João Paulo Coelho
Instituto Politécnico de Bragança
Campus de Santa Apolónia
5300-253 Bragança - Portugal

Instituto Politécnico de Bragança
ISBN: 978-972-745-281-1

Welcome

On behalf of the Conference CONTROLO'2020 Committees, we welcome you to attend the 14th International Conference on Automatic Control and Soft-Computing to be performed online, being organized from Bragança, Portugal, from 1 to 3 of July 2020.

Going to a conference is always an opportunity to establish contacts with other researchers and to grow culturally. Often, from informal conversations fostered by the conferences social program, synergies are generated, leading to new ideas and partnerships. Indeed, networking is a fundamental reason for being present at any conference. Moreover, every time we visit a new country, distinct realities are observed and a kind of mild acculturation happens. Experiences gathered from travelling, shape our vision of the world and promotes cultural enrichment. The CONTROLO'2020 conference was intended to be, not only a scientific event, but also to give the opportunity for the control community to know Bragança, to know the Polytechnic Institute of Bragança and to network face to face in friendly, safe, stimulating and international environment. The city was prepared to receive this scientific community, with a welcome reception at the Castle of Bragança and a gala dinner at the gardens of the Abade de Baçal museum, providing all the participants to get in touch with some of the most important landmarks of the Bragança cultural heritage. The ideal situation would be to communicate face to face, but due to the current pandemic situation, we were forced to change the CONTROLO'2020 conference to an online event.

From a health and security perspective, the benefit of holding the online conference is that it allows attendees to avoid crowd contact and effectively prevent virus propagation. Moreover, travelling between countries are, at the time we write this welcome letter, difficult if not impossible. In spite of all these difficulties, the decision to maintain the date of this event proves the resilience of APCA in adapting to extreme conditions. In addition, it was also important in this decision making, to ensure that the dissemination of the research and development works, submitted and accepted for publication, would be made public in due time. As mentioned earlier, much is lost with this decision as a conference is much more than a meeting aimed to purely scientific matters. Nevertheless,

we hope this will be a memorable, valuable, and enjoyable experience! We hope that all participants and other interested readers benefit scientifically from the proceedings and we wish you success in your technical presentations and networking. Even with all the mentioned constraints, all the involved persons and entities, gave an energetic response, providing all the necessary support for an event of this dimension, making it real, even during the current difficult times we all experience.

Once again, thanks for your support to the CONTROLO'2020 conference.

The CONTROLO'2020 local organization committee,

José Gonçalves, Manuel Braz-César and João Paulo Coelho

Contents

Instructions for Presenters

Time Zone: All conference times are based on Lisbon Time (GMT+1).

Technical Equipment Required:

- Stable Internet connection
- Computer, microphone and webcam

In order to produce good quality presentations, it is suggested the use of:

- Quiet environment
- Proper lighting

Time for Presentation and Discussion:

- Presentation: 15 minutes
- Discussion: 5 minutes

Zoom Instructions:

- ZOOM download link: https://zoom.us/download
- To avoid interruption caused by the unstable network during your presentation, the CONTROLO'2020 organizers strongly recommends that the authors have a presentation recorded, previously sent to the conference organization. We will play it for you if an accident occurs during the presentation.

Organization

This conference is organised under the sponsorship of the Portuguese Association of Automatic Control (APCA), a national member organization of the International Federation of Automatic Control (IFAC), and aims to promote scientific information interchange and informal networking in the fields of Automatic Control and Soft-Computing applied to control problems.

General Chair

José Alexandre de Carvalho Gonçalves
Instituto Politécnico de Bragança
Campus de Santa Apolónia
5300-253 Bragança - Portugal

Vice-Chairs

Manuel Teixeira Braz César
Instituto Politécnico de Bragança
Campus de Santa Apolónia
5300-253 Bragança - Portugal

João Paulo Coelho
Instituto Politécnico de Bragança
Campus de Santa Apolónia
5300-253 Bragança - Portugal

Organization Members

Alberto Jorge Lebre Cardoso
Portuguese Association of Automatic Control President
University of Coimbra (UC)

Filomena Maria Rocha Menezes Oliveira Soares
University of Minho (UM)

João Paulo Coelho
Polytechnic Institute of Bragança (IPB)

José Alexandre de Carvalho Gonçalves
Polytechnic Institute of Bragança (IPB)

José Boaventura Ribeiro da Cunha
University of Trás-os-Montes and Alto Douro (UTAD)

Manuel Teixeira Braz César
Polytechnic Institute of Bragança (IPB)

José Paulo Barroso de Moura Oliveira
University of Trás-os-Montes and Alto Douro (UTAD)

Committees

Steering Committee

António Dourado Correia Universidade de Coimbra, Portugal

Francisco R. Rubio Universidad de Sevilla, Spain

João Hespanha University of California, USA

João Miranda Lemos Instituto Superior Técnico, Portugal

Michel Kinnaert Université Libre de Bruxelles, Belgium

Sebastião Feyo de Azevedo Universidade do Porto, Portugal

Scientific Committee

Chair

Jan Maciejowski University of Cambridge, UK

Co-Chair

António Pedro Aguiar Universidade do Porto, Portugal

Members

Adina Astilean Universitatea Tehnica din Cluj-Napoca, Romania

Agustín Jiménez Universidad Politécnica de Madrid, Spain

Alberto Cardoso Universidade de Coimbra, Portugal

Alberto Isidori Sapienza Università di Roma, Italy

Amélia Caldeira Instituto Politécnico do Porto, Portugal

Ana Antunes Instituto Politécnico de Setúbal, Portugal

André Gustavo Conceição Federal University of Bahia, Brazil

Andrew Sung University of Southern Mississippi, USA

Andrzej Dzielinski Warsaw University of Technology, Poland

Anna Costa Universidade de S. Paulo, Brazil

Anthony Bloch University of Michigan, USA

Antonio Barreiro Blas Universidad de Vigo, Spain

António Dourado Universidade de Coimbra, Portugal

António Fernando Ribeiro Universidade do Minho, Portugal

António Paulo Moreira Universidade do Porto, Portugal

António Pedro Aguiar Universidade do Porto, Portugal

António Ruano Universidade do Algarve, Portugal

Antonio Sala Universitat Politecnica de Valencia, Spain

António Visioli University of Brescia, Italy

Bartlomiej Beliczynski Warsaw University of Technology, Poland

Bernardete Martins Ribeiro Universidade de Coimbra, Portugal

Boris Mordukhovich Wayne State University, USA

Bruno Guerreiro Universidade Nova de Lisboa, Portugal

Bruno Siciliano Università degli Studi di Napoli Frederico II, Italy

Calim Ciufudean Universitatea Stefan cel Mare Suceava, Romania

Camerlia Avram Universitatea Tehnica din Cluj-Napoca, Romania

Carla Pinheiro Universidade de Lisboa, Portugal

Carlos António Costa Laboratório Nacional de Engenharia Civil, Portugal

Carlos Balsa Instituto Politécnico de Bragança, Portugal

Carlos Cardeira Universidade de Lisboa, Portugal

Carlos Cugnasca Escola Politécnica da Universidade de São Paulo, Brazil

Carlos Fonseca Universidade de Coimbra, Portugal

Carlos Henrique Santos Universidade Estadual do Oeste do Paraná, Brazil

Carlos Silvestre Universidade de Lisboa, Portugal

Cesar Prada Moraga Universidad de Valladolid, Spain

Claudio Melchiori Università di Bologna, Italy

Constantino Lagoa Pennsylvania State University, USA

Damir Vrancic Jozef Stefan Institute, Slovenia

Dariuz Sedziak Poznan University of Technology, Poland

Eduardo Camacho Universidad de Sevilla, Spain

Erwin-Christian Lovasz Universitatea Politehnica Timioara, Romania

Estela Bicho Universidade do Minho, Portugal

Fátima Silva Leite Universidade de Coimbra, Portugal

Felipe Pait Universidade de São Paulo, Brazil

Felippe de Souza Universidade da Beira Interior, Portugal

Fernanda Coutinho Instituto Superior de Engenharia de Coimbra, Portugal

Fernando Fontes Universidade do Porto, Portugal

Filipe Martins Rodrigues Siemens, Portugal

Filomena Soares Universidade do Minho, Portugal

Francisco Rubio Universidad de Sevilla, Spain

Françoise Lamnabhi-Lagarrigue Laboratoire des Signaux et Systèmes, France

Frank Allgower University of Stuttgart, Germany

Gabor Sziebig Artic University of Norway, Norway

Gerardo Acosta U. del Centro de la Provincia de Buenos Aires, Argentina

Getúlio Paulo Igrejas Instituto Politécnico de Bragança, Portugal

Giovanni Indiveri University of Salento in Lecce, Italy

Giuseppe Notarstefano University of Salento in Lecce, Italy

Graça Ruano Universidade do Algarve, Portugal

Guilherme Kunz Universidade Estadual do Oeste do Paraná, Brasil

Guy Dumont University of British Columbia, Canada

Hitay Özbay Bilkent University, Turkey

Husi Géza Debreceni Egyetem, Hungary

Isabel Ribeiro Universidade de Lisboa, Portugal

Ívan Díaz Universidad Politécnica de Madrid, Spain

Javier Jiménez-Alonso Universidad Politécnica de Madrid, Spain

Javier Sanchis Sáez Universitat Politecnica de Valencia, Spain

Jean-Baptiste Mouret I. N. R. en Informatique et en Automatique, France

Jerome Jouffroy University of Sourthern Denmark, Denmark

Jerome Mendes University of Coimbra, Portugal

João Calado Instituto Superior de Engenharia de Lisboa, Portugal

João Hespanha University of California at Santa Barbara, USA

João Miguel Ferreira Universidade dos Açores, Portugal

João Miranda Lemos INESC TEC, Portugal

João Paulo Coelho Instituto Politécnico de Bragança, Portugal

João Sena Esteves Universidade do Minho, Portugal

John Fasoulas Creta Technical Education Institute, Greece

Jonas Sjöberg Chalmers University of Technology, Sweden

Jorge Martins Universidade de Lisboa, Portugal

José Barbosa MORE Colab, Portugal

José Boaventura-Cunha Univ. de Trás-os-Montes e Alto Douro, Portugal

José Carlos Príncipe University of Florida, USA

José de Carvalho Gonçalves Instituto Politécnico de Bragança, Portugal

José Manuel Soria Universidad Politecnica de Madrid, Portugal

José Mendes Machado Universidade do Minho, Portugal

José Moreno Universidad Nacional de Educación a Distancia, Spain

José Ragot Université de Lorraine, France

José Sá da Costa Universidade de Lisboa, Portugal

José Sánchez Universidade Nacional de Educação à Distância, Spain

Josenalde Oliveira Universidade Federal do Rio Grande do Norte, Brazil

József Bokor Computer and Automation Research Institute, Hungary

Jurek Sasiadek Carleton University, Canada

Justina Trojanowska Poznan University of Technology, Poland

Katalin Hangos University of Veszprém, Hungary

Katarina Zakova Slovak University of Technology in Bratislava, Slovakia

Klaus Schilling Julius-Maximilians-Universität Würzburg, Germany

Knut Hüper University of Wurzburg, Germany

Krzysztof Kozlowski Poznan University of Technology, Poland

Krzysztof Tchon Wroclaw University of Technology, Poland

Leonardo Honório Universidades Federais de Itajubá, Brazil

Leonilde Varela Universidade do Minho, Portugal

Lino de Oliveira Santos Universidade de Coimbra, Portugal

Luciano Antonio Mendes Pontifícia Universidade Católica do Paraná, Brazil

Luís Filipe Figueira Brito Palma Universidade Nova de Lisboa, Portugal

Luís Tiago Paiva Universidade do Porto, Portugal

Manuel Domínguez Gonzalez Universidad de Leon, Spain

Manuel Teixeira Braz César Instituto Politécnico de Bragança, Portugal

Marcelo Petry Universidade Federal de Santa Catarina, Brazil

Marcin Iwanowski Warsaw University of Technology, Poland

Maria de Amorim Ferreira Universidade do Porto, Portugal

Miguel Ángel Conde Universidad de León, Spain

Miguel Ayala Botto Universidade de Lisboa, Portugal

Miguel Bernal Instituto Tecnólogico de Sonora, Mexico

Miguel Salichs Universidad Carlos III de Madrid, Spain

Mikulas Huba Slovak University of Technology in Bratislava, Slovakia

Morgado Dias Universidade da Madeira, Portugal

Oscar Barambones Universidad del País Vasco, Spain

Paula Rocha Malonek Universidade do Porto, Portugal

Paulo Alexandre Afonso Universidade de Coimbra, Portugal

Paulo Costa Universidade do Porto, Portugal

Paulo Garrido Universidade do Minho, Portugal

Paulo Gil Universidade Nova de Lisboa, Portugal

Paulo Jorge Leitão Instituto Politécnico de Bragança, Portugal

Paulo Lopes dos Santos Universidade do Porto, Portugal

Paulo Moura Oliveira Universidade de Trás-os-Montes e Alto Douro, Portugal

Paulo Oliveira Universidade de Lisboa, Portugal

Pedro Albertos Universitat Politècnica de València, Spain

Pedro Peres Universidade Estadual de Campinas, Brazil

Peter Fleming University of Sheffield, United Kingdom

Pierre-Antoine Absil University of Louvain, Belgium

Ramon Vilanova Universidad Autonoma de Barcelona, Spain

Riccardo Scattolini Politecnico de Milano, Italy

Richard Bowden University of Surrey, United Kingdom

Robert Babuska Technical University of Delft, Netherlands

Robert F. Harrison University of Sheffield, United Kingdom

Roberto Zanetti Freire Pontifícia Universidade Católica do Paraná, Brazil

Rui Araújo Universidade de Coimbra, Portugal

Rui Carneiro de Barros Universidade do Porto, Portugal

Rui Francisco Moura Bastos Universidade de Coimbra, Portugal

Sahin Yildirim Erciyes Üniversitesi, Turkey

Sandra Isabel Ricardo Universidade de Trás-os-Montes e Alto Douro, Portugal

Sebastian Dormido Universidad Nacional de Educación a Distancia, Spain

Sebastião Feyo de Azevedo Universidade do Porto, Portugal

Silvia Botelho Universidade Federal do Rio Grande, Brazil

Silviu-Iulian Niculescu University Paris-Sud, France

Sofia Oliveira Lopes Universidade do Minho, Portugal

Steven Ding Universität Duisburg-Essen, Germany

Susana Margarida da Silva Vieira Universidade de Lisboa, Portugal

Tatiana Pinho INESC TEC, Portugal

Teresa Perdicoulis Universidade de Trás-os-Montes e Alto Douro, Portugal

Tore Hägglund Lund Institute of Technology, Sweden

Velimir Jurdjevic University of Toronto, Canada

Wojciech Giernacki Poznan University of Technology, Poland

Zhan Shu University of Southampton, United Kingdom

Invited Plenary Lectures

"COLIBRI: A twin wing flapping robot of the size of a hummingbird capable of hovering"

Prof. André Preumont

Short Bio: André Preumont received his MSc in Aeronautics from the University of Liege (Belgium) in 1973 and his PhD in Applied Sciences in 1981. He spent 10 years in the nuclear industry before moving in academia. He has been a professor of Mechanical Engineering and Robotics at the Université Libre de Bruxelles (ULB) since 1987, full professor and director of the Active Structures Laboratory from 1991 to 2016, then Emeritus. His current researches include Adaptive Optics, Active damping of space structures and flapping wing robots. He is the author of 7 books. He is a member of the Belgian Royal Academy and of the French Académie de l'Air et de l'Espace (AAE). He was the recipient of the Alexander von Humboldt Research Award in 2011 (Darmstadt, Germany). He was a visiting professor at Virginia Tech (USA), UT Compiègne and INSA Lyon (France), and Politecnico di Milano (Italy). He is a Fellow of the American Institute of Aeronautics and Astronautics (AIAA).

Abstract: The project aims at designing and constructing a twin wing, tailless flapping wing robot of the size of a hummingbird with emphasis on biomimetic flight. The project started in 2010; the various steps of the project include: wing aerodynamics, flapping wing mechanism, stability and control (the system is naturally unstable), flight dynamics, power consumption, flight simulation and flight testing. The vehicle weights a little more than 20 grams for a wing span of 21 cm; the flapping frequency is 22 Hz. The maiden flight took place in June 2016. Since then, the research has been focused on improving the flight quality, exploring the aeroelastic coupling and extending the flight time. A short video can be seen on this link.

Plenary Session Chair: Manuel Braz César (IPB)

"On the control of solar thermal plants"

Prof. Eduardo F. Camacho

Short Bio: Eduardo F. Camacho received the Ph.D. degree in electrical engineering from the University of Seville, Seville, Spain. He is now a Full Professor with the Department of System and Automation Engineering, University of Seville. He is author of Model Predictive Control in the Process Industry (1995), Advanced Control of Solar Plants (1997), Model Predictive Control (1999), (Springer, 2004, 2nd edition), Control e Instrumentacion de Procesos Quimicos (Ed. Sintesis), Control of Deadtime Processes (Springer, 2007) and Control of Solar Systems (Springer, 2011, translated and printed in China Machine Press 2014) He has served on various IFAC technical committees and chaired the IFAC publication Committee from 2002-2005. He was the president of the European Control Association (2005-2007) and chaired the IEEE/CSS International Affairs Committee (2003-2006), Chair of the IFAC Policy Committee and a member of the IEEE/CSS Board of Governors and he is currently a member of the IFAC Council. He has acted as evaluator of projects at national and European level and was appointed Manager of the Advanced Production Technology Program of the Spanish National R&D Program (1996-2000). He was one of the Spanish representatives on the Program Committee of the Growth Research program and expert for the Program Committee of the NMP research priority of the European Union. He has carried out reviews and editorial work for various technical journals and many conferences. He has been one of the Editors of the IFAC Journal, Control Engineering Practice, Editor-at-Large of the European Journal of Control and Subject Editor of Optimal Control:Methods and Applications. Dr. Camacho is an IEEE and IFAC Fellow. He was Publication Chair for the IFAC World Congress 2002, General Chair of the joint 44th IEEE CDC-ECC 2005, and co-General Chair of the joint 50th IEEE CDC-ECC 2011. He has recently been awarded an Advanced Grant by the European Research Council for a project consisting in the integrating solar radiation sensors mounted in drones for controlling solar plants.

Abstract: The use of renewable energy, such as solar energy, experienced a great impulse during the second half of the seventies just after the first big oil crisis. At that time economic issues were the most important factors and the interest in these types of processes decreased when the oil prices fell. There is a renewed interest in the use of renewable energies nowadays driven by the need of reducing the high environmental impact produced by the use of fossil energy systems. There are two main drawbacks of energy systems: a) the resulting energy costs are not yet competitive and b) solar energy is not always available when needed. Considerable research efforts are being devoted to techniques which may help to overcome these drawbacks, control is one of those techniques. A thermal solar power plant basically consists of a system where the solar energy is collected, then concentrated and finally transferred to a fluid. The thermal energy of the hot fluid is then used for different purposes such as generating electricity, the desalination

of sea water etc. While in other power generating processes, the main source of energy (the fuel) can be manipulated as it is used as the main control variable, in solar energy systems, the main source of power which is solar radiation cannot be manipulated and furthermore it changes in a seasonal and on a daily base acting as a disturbance when considering it from a control point of view. Solar plants have all the characteristics needed for using advanced control strategies able to cope with changing dynamics, (nonlinearities and uncertainties). As fixed PID controllers cannot cope with some of the mentioned problems, they have to be detuned with low gain, producing sluggish responses or if they are tightly tuned they may produce high oscillations when the dynamics of the process vary, due to environmental and/or operating conditions changes. The use of more efficient control strategies resulting in better responses would increase the number of operational hours of the plants. The talk describes the main solar thermal plants, the control problems involved and how control systems can help in increasing their efficiency. Some illustrative examples are given.

Plenary Session Chair: José Boaventura (UTAD)

"Cyber-physical control of automated transport systems and their influence on road traffic"

Prof. Karl H. Johansson

Short Bio: Karl H. Johansson is Professor at the School of Electrical Engineering and Computer Science, KTH Royal Institute of Technology, Sweden. He received MSc and PhD degrees from Lund University. He has held visiting positions at UC Berkeley, Caltech, NTU, HKUST Institute of Advanced Studies, and NTNU. His research interests are in networked control systems, cyber-physical systems, and applications in transportation, energy, and automation. He is a member of the Swedish Research Council's Scientific Council for Natural Sciences and Engineering Sciences. He has served on the IEEE Control Systems Society Board of Governors, the IFAC Executive Board, and is currently Vice-President of the European Control Association Council. He has received several best paper awards and other distinctions from IEEE, IFAC, and ACM. He has been awarded Distinguished Professor with the Swedish Research Council and Wallenberg Scholar with the Knut and Alice Wallenberg Foundation. He has received the Future Research Leader Award from the Swedish Foundation for Strategic Research and the triennial Young Author Prize from IFAC. He is Fellow of the IEEE and the Royal Swedish Academy of Engineering Sciences, and he is IEEE Control Systems Society Distinguished Lecturer.

Abstract: Automated and connected road vehicles enable large-scale control and optimization of the transport system with the potential to radically improve energy efficiency, decrease the environmental footprint, and enhance safety. Freight transportation accounts for a significant amount of all energy consumption and greenhouse gas emissions. In this talk, we will discuss the potential future of road goods transportation and how it can be made more robust and efficient, from the automation of individual long-haulage trucks to the optimization of fleet management and logistics. In this talk we will focus on automated heavy-duty vehicle platooning, which is currently being implemented and evaluated by several truck manufacturers world-wide. We will discuss how to deploy feedback control of individual platoons utilising the cellular communication infrastructure and how such controlled platoons can be used improve overall traffic conditions. It will be argued that the average total variation of traffic density can be reduced and thereby creating incentives for platooning beyond fuel savings and driver support. Extensive experiments done on European highways will illustrate system performance and safety requirements. The presentation will be based on joint work with collaborators at KTH and at the truck manufacturers Scania and Volvo.

Plenary Session Chair: João Paulo Coelho (IPB)

"Can feedback control attenuate mental illness?"

Prof. Kevin M. Passino

Short Bio: Kevin M. Passino received his Ph.D. in Electrical Engineering from the University of Notre Dame in 1989. He is currently a Professor of Electrical and Computer Engineering and directs the Technology for Mental Health research group. He as the Director of the Humanitarian Engineering Center at The Ohio State University. He was on the IEEE Humanitarian Engineering Activities Committee. He has served as the Vice President of Technical Activities of the IEEE Control Systems Society (CSS); was an elected member of the IEEE Control Systems Society Board of Governors; was the Program Chair of the 2001 IEEE Conf. on Decision and Control. He is a Fellow of the IEEE. He is co-editor (with P.J. Antsaklis) of the book "An Introduction to Intelligent and Autonomous Control", Kluwer Academic Press, 1993; co-author (with S. Yurkovich) of the book "Fuzzy Control", Addison Wesley Longman Pub., 1998; co-author (with K.L. Burgess) of the book "Stability Analysis of Discrete Event Systems", John Wiley and Sons, NY, 1998; co-author (with V. Gazi, M.L. Moore, W. Shackleford, F. Proctor, and J.S. Albus) of the book "The RCS Handbook: Tools for Real Time Control Systems Software Development", John Wiley and Sons, NY, 2001; co-author (with J.T. Spooner, M. Maggiore, R. Ordonez) of the book "Stable Adaptive Control and Estimation for Nonlinear Systems: Neural and Fuzzy Approximator Techniques", John Wiley and Sons, NY, 2002; author of "Biomimicry for Optimization, Control, and Automation", Springer-Verlag, London, UK, 2005; and co-author (with V. Gazi) of the book "Swarm Stability and Optimization", Springer-Verlag, Heidelberg, Germany, 2011; author of "Humanitarian Engineering: Advancing Technology for Sustainable Development", Edition 3, Bede Pub., OH, 2016. More information can be found here.

Abstract: Two new application areas for feedback control science and engineering are introduced for mental health. First, (i) it is explained how stress can be measured in real-time via "heart rate variability" and used to modulate music for stress regulation, and (ii) an overview of initial work on generalizing this approach is provided where a calming method is to be used in a classroom of children, many of whom have been traumatized. Second, our early results show that electroencephalogram (EEG) signals from brain waves can be used to modulate either music or light for the regulation of "frontal alpha asymmetry" which is correlated with depression.

Plenary Session Chair: Paulo Moura Oliveira (UTAD)

"Fundamentals of automatic control: What to teach? How to teach it? How to evaluate what has been learned?"

Prof. Sebastián Dormido

Short Bio: Sebastián Dormido received the B.S. degree in Physics from Complutense University of Madrid, Spain, in 1968, the Ph.D. degree in Physics from the University of the Basque Country, Bilbao, Spain, in 1971. In 1981, he was appointed Professor of Control Engineering at the National Distance Education University (UNED), Madrid. He has served as Vice rector of Research (1983-1985) in UNED and he is now emeritus professor at UNED. His research interests are: Computer Control, Event Based Control, Modelling-Simulation and Control Education with emphasis on Remote and Virtual labs. He has authored or co-authored over 350 technical papers in international journals and conferences and has supervised 40 Ph.D. students. From 2001-2006 has been President of the Spanish Association of Automatic Control (CEA). In 2007 received a Doctor Honorary Degree from Universidad de Huelva, in 2008 the National Automatic Control prize from Spanish Automatic Control Committee and in 2013 received a Doctor Honorary Degree from Universidad de Almería. From 2014-2016 has been Chair of the IFAC Technical Committee on Control Education (TC9.4) and from 2015-2016 Chair of the IEEE CSS Technical Committee on Control Education. In 2019 received the IFAC Control Education Life Time Achievement Award.

Abstract: The needs of industry for well-trained control systems scientists and engineers are changing, due to marketplace pressures and the tremendous advances in technology. Future generations of control engineering students will have to be broadly educated to cope with cross-disciplinary applications and rapidly changing technology. At the same time, the backgrounds of students are changing. Many come from nontraditional disciplines; they often are less well prepared in mathematics and the sciences while being better adapted to work with modern computing technologies. The time is thus ripe for major renovations in control and systems engineering education.

From this perspective the purpose of this talk is to present some thoughts and personal experiences of 45 academic courses teaching introductory courses of automatic control. Since that time the changes in technology without doubt have been unbelievable and exceeded all serious predictions and for that reason it makes sense to utilize these facilities to improve the student teaching and learning environment. The material covered in most first control courses is still quite similar to that which I covered at my first attempt. This has been the general rule and most of the academic staff often teach a course which is largely the same as it has been for 40 years or more in terms of both academic content and evaluation.

Although it is true that every subject has fundamental concepts, that remain unchanged over time and which must be understood by a student, do we teach these aspects for control engineering in the most efficient way given today's technology?

The presentation makes a critical analysis of the use of interactive control tools and the deploy of virtual and remote laboratories at the National University of Distance Education (UNED) where the author has carried out his academic work in the last 35 years.

Plenary Session Chair: José Gonçalves (IPB)

MATLAB Course

"Deep Reinforcement Learning with MATLAB & Simulink"

Carlos Sanchis

Short Bio: Carlos Sanchis is an engineer at the MathWorks Academic Group, where he's responsible for the collaboration with academics and their institutions in Portugal and Spain.

He holds master's degrees in Industrial Engineering (from the Technical University of Valencia) and Project Management (La Salle Business Engineering School) and his research interests lie at the intersection of controls and data science.

Before joining the MathWorks, he had worked on power grid modelling, electronics and data analytics projects in industrial, R&D and academic positions at different organizations including his *alma mater*, Hewlett-Packard and Iberdrola.

Abstract: In this workshop, we'll employ Deep Reinforcement Learning to train a biped robot through simulation to walk safely and optimally following a straight line.

Designing autonomous systems (robots, vehicles, virtual assistants...) requires solving complex optimal control problems that are difficult to undertake because it's hard to define a control strategy or the objectives for each variable.

Machine Learning makes it possible to train "black box" algorithms with example data to tackle sophisticated tasks. Lying at the intersection with Game Theory, Reinforcement Learning is probably the branch with the most promising future in Automatic Control. By means of it, "agents" learn "policies" (control strategies) through trial and error. In order for these policies and the training process to be sophisticated enough, it's often useful to implement them with deep neural networks.

In our example, we'll start with a 3D physical model of the robot in Simscape

Multibody™. We'll craft an accurate enough model of the environment and its rewards in Simulink. With Deep Learning Toolbox™, we'll design neural networks to codify a Reinforcement Learning algorithm and the agent's policy. Then we'll run several simulations in a parallel cluster and, once the agent is trained, we'll see how to deploy it to a programmable controller in the real robot through automatic C++ code generation.

The course is free but you must register here.

Highlights:

- Foundations of modern Reinforcement Learning;
- Applications to autonomous control systems;
- Training agents in a safe virtual environment;
- Easy deployment to embedded devices.

Who Should Attend: This session is aimed at academics interested in Reinforcement Learning, its applications to Control Engineering and the practical aspects of implementing this strategy with MATLAB, Simulink and Reinforcement Learning Toolbox™.

Conference Program

Wednesday, 1 of July

09:30 - 19:30	**Secretariat**	
09:40 - 10:00	**Opening Session**	
10:00 - 11:00	**Plenary Session I** "On the control of solar thermal plants" Prof. Eduardo F. Camacho	
Parallel Sessions	**Nonlinear Data: Theory & Applications I**	**Control Theory I**
Session Chairs	*Knut Hüper* *Luís Camacho*	*João M. Lemos* *Paulo Garrido*
11:05 - 11:25	"Sub-Riemannian geodesics on nested principal bundles" - Irina Markina and Mauricio Molino	"Predictive Functional Control for Unstable First-Order Dynamic Systems" - Muhammad Saleheen Aftab, John Anthony Rossiter and Zhiming Zhang
11:25 - 11:45	"A comparative Study of Dynamic Mode Decomposition and Dynamical Component Analysis" - Moritz Kern, Monika Warmuth and Christian Uhl	"Gas Network Hierarchical Optimisation" - Teresa Paula Perdicoulis and P. Lopes dos Santos
11:45 - 12:05	"Rolling on affine tangent planes: Parallel transport and the associated sub-Riemannian problems" - Velimir Jurdjevic	"Double back-calculation approach to deal with input saturation in cascade control problems" - Marta Leal, Ángeles Hoyo Sánchez, Jose Luis Guzman and Tore Hägglund
12:05 - 12:25	"Geometric algorithm to generate interpolating splines on Grassmann and Stiefel manifolds" - Luis Machado, Fátima Silva Leite and Ekkehard Batzies	"A state-space model inversion control method for shake table systems" - Jose Ramírez, Jaime H. García Palacios and Iván Muñoz Díaz

12:25 - 12:45	**Networking**	
12:45 - 14:00	**Lunch Break**	
14:00 - 15:00	**Plenary Session II** "COLIBRI: A twin wing flapping robot of the size of a hummingbird capable of hovering" Prof. André J. Preumont	
Parallel Sessions	**Control Engineering and Industrial Automation Education**	**Predictive Control**
Session Chairs	*John Anthony Rossiter* *Filomena Soares*	*Margarida Nabais* *Silvia Zanoli*
15:05 - 15:25	"Your turn to learn! – Flipped Classroom in Automation Courses" - Filomena Soares, Paulo Oliveira and Celina Leão	"An approach to model validation for Model Predictive Control based on Dvurecenska's metrics" - Victor Dreke, Manuel Serrano and Claudio Garcia
15:25 - 15:45	"Concepts of threshold assessment for a first course in control engineering" - John Anthony Rossiter	"Distributed Adaptive Predictive Control Based on Switched Multiple Models and ADMM" - Margarida Nabais and Joao M. Lemos
15:45 - 16:05	"Bridging Theory to Practice: Feedforward and Cascade Control with TCLab Arduino Kit" - Paulo Moura Oliveira, John Hedengren and José Boaventura	"Optimization of the clinker production phase in a cement plant" - Silvia Zanoli, Lorenzo Orlietti, Francesco Cocchioni, Giacomo Astolfi and Crescenzo Pepe
16:05 - 16:25	"Prototyping and Control of a Conveyor Belt: An educational Experiment in Mechatronics" - José Gonçalves, João Ribeiro and Paulo Costa	"Model Predictive Control of a pusher type reheating furnace" - Silvia Zanoli, Francesco Cocchioni, Chiara Valzecchi and Crescenzo Pepe
16:25 - 16:45	"Teaching Neural Control with an Arduino Based Control Kit" - Ramiro Barbosas	"MPC Framework for Supply Chain Management Integrating On-time Delivery and Transport Management" - Eduardo Araújo, João Lemos Nabais and Miguel Ayala Botto

16:45 - 17:05	"Trajectory planning for landing with a direct optimal control algorithm" - Bertinho Costa and João M. Lemos	"Fractional Order Predictive Control for Trajectory Tracking of the AR.Drone Quadrotor" - Ricardo Diaz, Shiquan Zhao, Douglas Guingla, Clara Ionescu and Robin De Keyser
17:05 - 17:25	**Networking**	
Parallel Sessions	**PID Control : Tuning, Design and Applications**	**Automation**
Session Chairs	*Ramón Vilanova* *Paulo Moura Oliveira*	*Ramiro Barbosa* *Salik Khanal*
17:25 - 17:45	"Temperature Control on Double-Pipe Heat-Exchangers: an application" - S.J. Costa, R.F. Ferreira and J.M. Igreja	"An IIoT Solution for SME's" - Bruno Cunha, Elder Hernandez, Filipe Ferreira, Rui Rebelo and Cristovão Sousa
17:45 - 18:05	"Differential Observation and Integral Action in LTI State-Space Controllers and the PID Special Case" - Paulo Garrido	"Home Energy Management System in an Algarve residence. First results" - Antonio Ruano, Karol Bot and Maria da Graça Ruano
18:05 - 18:25	"Robustness issues in Event-Based PI control systems: Internal Model Control tuning" - Ramon Vilanova, Carles Pedret, Marian Barbu, Manuel Beschi and Antonio Visioli	"Open Hardware and Software Entry-Level Robotics Competition" - Vítor Hugo Pinto, Armando Sousa, Jose Lima, José Gonçalves and Paulo Costa
18:25 - 18:45	"Practical Validation of a Dual Mode Feedforward-Feedback Control Scheme in an Arduino Kit" - Paulo Moura Oliveira and Damir Vrancic	"Engine Labels Detection for Vehicle Quality Verification in the Assembly Line: A Machine Vision Approach" - Sílvio Capela, Rita Silva, Ana Campaniço, Salik Khanal, João Barroso and Vítor Filipe
18:45 - 19:05	"Addendum to 'Seeking a unique view to control of simple systems'" - Mikulas Huba	"Prototyping of a low-cost stroboscope to be applied in condition maintenance: An open hardware and software approach" - Laiany Brancalião, Caio Camargo, José Gonçalves and José Lima
19:05 - 19:25	**Networking** **End of Day #1**	

Thursday, 2 of July

09:30 - 19:30	**Secretariat**	
10:00 - 11:00	**Plenary Session III** "Fundamentals of automatic control: What to teach? How to teach it? How to evaluate what has been learned?" Prof. Sebastián Dormido	
Parallel Sessions	**Nonlinear Data: Theory & Applications II**	**Control Theory II**
Session Chairs	*Knut Hüper* *Luís Camacho*	*Teresa Perdicoulis* *Thérèze Azar*
11:05 - 11:25	"State-space estimation using the behavioral approach: a simple particular case" - Lorenzo Ntogramatzidis, Ricardo Pereira and Paula Rocha	"An Approximated Constrained Optimal Output Feedback Fallback Control under Variable Parameters" - Christian Kallies, Mohamed Ibrahim and Rolf Findeisen
11:25 - 11:45	"Cubic splines in the Grassmann manifold" - Fátima Pina and Fátima Silva Leite	"Distributed LQ control of a water delivery canal based on a selfish game" - João Belfo, João M. Lemos and António Aguiar
11:45 - 12:05	"An Extrinsic Approach to Sub-Riemannian Geodesics on the Orthogonal Group" - Knut Hüeper, Irina Markina and Fátima Silva Leite	"Stabilization using in-domain actuator: a numerical method for a non linear parabolic partial differential equation" - Thérèse Azar, Laetitia Perez, Christophe Prieur, Emmanuel Moulay and Laurent Autrique
12:05 - 12:25	"Existence and uniqueness for Riemannian cubics" - Margarida Camarinha, Fátima Silva Leite and Peter Crouch	"Direct Power Control of a Doubly Fed Induction Generator Using a Lyapunov Based State Space Approach" - Yassine Boukili, A. Pedro Aguiar and Adriano Carvalho
12:25 - 12:45	**Networking**	
12:45 - 14:00	**Lunch Break**	

14:00 - 15:00	**Plenary Session IV** "Can feedback control attenuate mental illness?" Prof. Kevin M. Passino	
Parallel Sessions	**Control in Robotic Applications**	**Soft-Computing Applied to Control**
Session Chairs	*António Paulo Moreira* *Paulo Costa*	*António Ruano* *Nuno Ferreira*
15:05 - 15:25	"Performance Enhancement of a Neato XV-11 Laser Scanner Applied to Mobile Robot Localization: A Stochastic Modeling Approach" - José Gonçalves, João Paulo Coelho, Manuel Braz-Cesar and Paulo Costa	"Dynamic Model for the pH in a Raceway Reactor using Deep Learning techniques" - Pablo Otálora, Jose Guzman, Manuel Berenguel and Gabriel Acien
15:25 - 15:45	"Welding process automation of aluminum alloys for the transport industry: An Industrial Robotics Approach" - >João Ribeiro, José Gonçalves and Nuno Mineiro	"A Fuzzy based model to assess the influence of project risk on corporate behavior" - Ricardo Santos, Antonio Abreu, João Calado, José Soares, José Martins and Vitor Anes
15:45 - 16:05	"A DOBOT Manipulator Simulation Environment for Teaching Aim with Forward and Inverse Kinematics" - Thadeu Brito, Jose Lima, João Neto, Paulo Costa and Luis Piardi	"Decentralized Control for Multi-Agent Missions based on Flocking Rules" - Rafael Ribeiro, Daniel Silvestre and Carlos Silvestre
16:05 - 16:25	"Using Multi-UAV for Rescue Environment Mapping: Task Planning Optimization Approach" - Ricardo Da Rosa, Thadeu Brito, Ana Pereira, Jose Lima and Marco Wehrmeister	"Classification of Car Parts using Deep Neural Network" - Salik Khanal, Eurico Vasco Amorim and Vitor Filipe
16:25 - 16:45	"Extrinsic Sensor Calibration Methods for Mobile Robots: A Short Review" - Ricardo Sousa, Marcelo Petry and António Paulo Moreira	"Control of bio-inspired multi-robots through gestures using convolutional neural networks in simulated environment" - Nuno Ferreira, José Boaventura, Aratã Saraiva and Domingos Bruno
16:45 - 17:25	**Networking**	

Parallel Sessions	**Control of Smart Structures**	**Robotics**
Session Chairs	*Iván Diaz* *Emiliano Pereira*	*José Lima* *Thadeu Brito*
17:25 - 17:45	"Study on the isolator-structure interaction. Influence on the supporting structure" - Jorge Pérez-Aracil, Emiliano Pereira-González, Iván Muñoz-Díaz and Paul Reynolds	"Cooperative circumnavigation for a mobile target using adaptive estimation" - Joana Fonseca, Jieqiang Wei, Tor Johansen and Karl Johansson
17:45 - 18:05	"A comparative performance study of inertial vibration controllers for an ultra-lightweight GFRP footbridge" - Carlos Renedo, Jose Soria, Iván Díaz and Christian Gallegos	"Cloud-Based Framework for Robot operation in Hospital Environments" - Nuno Ferreira and J Boaventura-Cunha
18:05 - 18:25	"Mitigation of earthquake-induced structural pounding between adjoining buildings: State-of-the-art" - Pedro Folhento, Rui Barros and Manuel Braz-César	"On the Use of a Maximum Correntropy Criterion in Kalman Filtering Based Strategies for Robot Localization and Mapping" - Matheus F. Reis, Hamed Moayyed and A. Pedro Aguiar
18:25 - 18:45	"Dynamic Survey of a Telecommunication Tower by Interferometric Radar Technique" - Fábio Paiva, Barros Rui, Jorge Henriques, Tiago Cunha, Pierre Feyfant and Manuel Braz-César	"Vision-Based Object Detection and Localization for Autonomous Airborne Payload Delivery" - Theo van Niekerk and James Sewell
18:45 - 19:05	"Motion-based Design of Semi-Active Tuned Mass Dampers to Control Pedestrian-Induced Vibrations in Footbridges under Uncertainty Conditions" - Javier Jiménez-Alonso and José Herrera	"LMI-based Sliding Mode Controller Design for an Uncertain Single-Link Flexible Robot Manipulator" - José Andrade and Christopher Edwards
19:05 - 19:25	**Networking** **End of Day #2**	

Friday, 3 of July

09:30 - 19:30	**Secretariat**	
10:00 - 11:00	**Plenary Session V** "Cyber-physical control of automated transport systems and their influence on road traffic" Prof. Karl H. Johansson	
Parallel Sessions	**Nonlinear Data: Theory & Applications II**	**Solar Energy and Agriculture**
Session Chairs	*Knut Hüper* *Luís Camacho*	*José Boaventura-Cunha* *Pablo Cano*
11:05 - 11:25	"LSLOCK: A Method to Estimate State Space Model by Spatiotemporal Continuity" - Tsuyoshi Ishizone and Kazuyuki Nakamura	"Calibration-free HCPV sun tracking strategy" - Manuel Satue, Manuel Ortega, Fernando Castaño, Francisco Rubio and Jose Fornes
11:25 - 11:45	"A decentralized strategy for variational collision avoidance on complete Riemannian manifolds" - Leonardo Colombo and Jacob Goodman	"Assessment of the nutritional state for olive trees using UAVs" - Pablo Marchal, Diego Gila, Juan Ortega, Javier García and Sergio Rico
11:45 - 12:05	"Endpoint Geodesics on the Set of Positive Definite Real Matrices" - Maximilian Stegemeyer and Knut Hueper	"CDM Controller Design of a Grid Connected Photovoltaic System" - João Coelho, Wojciech Giernacki, José Boaventura and José Gonçalves
12:05 - 12:25	"Accelerated Generalized Correntropy Interior Point Method in Power System State Estimation" - Hamed Moayyed, Diyako Ghaderyan, Yassine Boukili and Pedro Aguiar	"Soiling Monitoring Modelling for Photovoltaic System" - Vitor Pagani, Nelson Los, Wellington Silva, Paulo Leitão, Marcio Casaro and Claudinor Nascimento
12:25 - 12:45	**Networking**	
12:45 - 14:00	**Lunch Break**	
14:00 - 17:00	**MATLAB Course** "Deep reinforcement learning with MATLAB & Simulink" Carlos Sanchis (MathWorks)	
17:00 - 17:25	**Networking**	

Parallel Sessions	**Control in Point Vortex Dynamics**	**Modelling**
Session Chairs	*Carlos Balsa* *Sílvio Gama*	*Paula Rocha* *Vítor Pinto*
17:25 - 17:45	"The numerical control of the motion of a passive particle in a point vortex flow" - Carlos Balsa and Sílvio Gama	"Identification and Control of Precalciner in the Cement Plant" - Jakub Osmic, Emir Omerdic, Edin Imsirovic, Tima Smajlovic and Edin Omerdic
17:45 - 18:05	"Minimum energy control of passive tracers advection in point vortices flow" - Carlos Balsa, Olivier Cots, Joseph Gergaud and Boris Wembe	"Control of the depth of anesthesia using a new model for the action of propofol and remifentanil on the BIS level" - Jorge Silva, Teresa Mendonça and Paula Rocha
18:05 - 18:25	"Passive Particle Dynamics in Viscous Vortex Flow" - Gil Marques, Maria Rodrigues and Sílvio Gama	"Model of a DC Motor with Worm Gearbox" - Vítor Pinto, José Gonçalves and Paulo Costa
18:25 - 18:45	"Optimal route planning in steady planar convective flows" - Roman Chertovskih, Maxim Staritsyn and Fernando Pereira	"Modeling of an Elastic Joint: An Experimental Setup Approach" - Vítor Pinto, José Lima, José Gonçalves and Paulo Costa
18:45 - 19:05		"On Control Models in the Motion Stabilization Problem of a Holonomic Mechanical System" - Aleksandr Andreev and Olga Peregudova
19:05 - 19:25	**Closing Session**	

Abstracts

Sub-Riemannian geodesics on nested principal bundles

July,1
11:05
Nonlinear Data - Theory & Applications I

Mauricio Godoy Molina[1] and Irina Markina[2]

[1]Departamento de Matemática y Estadística, Universidad de La Frontera, Temuco, Chile
[2]Department of Mathematics, University of Bergen, Bergen, Norway

We study the interplay between geodesics on two non-holonomic systems that are related by the action of a Lie group on them. After some geometric preliminaries, we use the Hamiltonian formalism to write the parametric form of geodesics. We present several geometric examples, including a non-holonomic structure on the Gromoll-Meyer exotic sphere and twistor space.

A Comparative Study of Dynamic Mode Decomposition (DMD) and Dynamical Component Analysis (DyCA)

July,1
11:25
Nonlinear Data - Theory & Applications I

Moritz Kern[1], Christian Uhl[1] and Monika Warmuth[1]

[1]Ansbach University of Applied Sciences, Center for Signal Analysis of Complex Systems, Residenzstr. 8, 91522 Ansbach, Germany

In the following sections two dimensionality reduction methods, dynamic mode decomposition (DMD) and dynamical component analysis (DyCA), are briefly introduced and applied on epileptic EEG data. DMD approximates a linear operator whose eigendecomposition describes the underlying system in frequency space. A reduction in dimensionality is achieved by retrospectively selecting relevant DMD modes. DyCA, on the other hand, naturally provides a dimensionality reduction by projecting onto a relevant subspace in time domain during the process.

July,1
11:45
Nonlinear Data - Theory & Applications I

Rolling on affine tangent planes: Parallel transport and the associated sub-Riemannian problems

V. Jurdjevic[1]

[1]Department of Mathematics, University of Toronto, Toronto, Ontario M5S 3G3, Canada

This paper is devoted to the extremal curves associated with a natural optimal control problem associated with the rolling distributions in which a symmetric Riemannian space rolls on it affine plane at a fixed point. We use the Maximum Principle of optimal control to derive the appropriate Hamiltonian equations. Then we show that this Hamiltonian system admits an isospectral representation, which then implies that the system is integrable. In addition , we make a connection with a certain canonical affine-quadratic Hamiltonian that shares the same integrals of motion with the rolling Hamiltonian. This connection provides a link with the elastic curves and the earlier publications on this topic, while at the same time raises interesting new questions.

July,1
12:05
Nonlinear Data - Theory & Applications I

Geometric algorithm to generate interpolating splines on Grassmann and Stiefel manifolds

L. Machado[1,2], F. Silva Leite[1,3] and E. Batzies[4]

[1]Institute of Systems and Robotics, DEEC-UC, 3030-789 Coimbra, Portugal
[2]Department of Mathematics, University of Trás-os-Montes e Alto Douro (UTAD),5000-801 Vila Real, Portugal
[3]University of Coimbra, Department of Mathematics, 3001-501 Coimbra, Portugal
[4]Faculty of Computer & Electrical Engineering, Hochschule Furtwangen University,78120 Furtwangen, Germany

In this paper, we present a simplified geometric algorithm to generate interpolating splines on Grassmann and Stiefel manifolds, where not only position but also orientation are required to change smoothly. In this construction, each spline segment is computed using local data only. It turns out that this algorithm does not require a recursive procedure and it is based on the explicit expressions for geodesics or quasi-geodesics on those manifolds.

July,1
11:05
Control Theory I

Predictive Functional Control for Unstable First-Order Dynamic Systems

Muhammad Saleheen Aftab[1], John Anthony Rossiter[1] and Zhiming Zhang[2]

[1]Dept. of Automatic Control and Systems Eng., University of Sheffield, UK
[2]State Key Laboratory of Industrial Control Technology, Zhejiang University, China

Predictive functional control (PFC) has emerged as a popular industrial choice owing to its simplicity and cost-effectiveness. Nevertheless, its efficacy diminishes when dealing with challenging dynamics because of prediction mismatch in such scenarios. This paper presents a proposal for reducing prediction mismatch and thus improving behaviour for simple unstable processes; a two-stage design methodology pre-stabilises predictions via proportional compensation before introducing the PFC component. It is demonstrated that pre-stabilisation reduces the dependency of the closed-loop pole on the coincidence point and also improves robustness to uncertainty. Simulation results verify the improved performance as compared to conventional PFC.

July,1
11:25
Control Theory I

Gas Network Hierarchical Optimisation

T-P Azevedo Perdicoúlis[1] and P. Lopes dos Santos [1]

[1]ISR, University of Coimbra & Eng. Dep at ECT UTAD, Portugal
[2]INESC TEC & EE Dep. at FEUP, University of Porto, Portugal

We describe the application of hierachical coordination to gas networks optimisation, requested by the problem decomposition. Special attention is given to the coordination part of an iterative algorithm where every agent finds its best settings based on the decisions of its nearest-neighbours. The result is a decentralised fixed-point algorithm whose structure is described in an algebraic setting of the kind of the transient optimisation problem, owing to the case study complexity. The method performance is assessed in three example-networks.

Double back-calculation approach to deal with input saturation in cascade control problems

July,1
11:45
Control Theory I

Marta Leal[1], Ángeles Hoyo[1], José Luis Guzmán[1], and Tore Hägglund[2]

[1]Department of Informatics, ceiA3, CIESOL, University of Almería, Ctra. Sacramento s/n, 04120 Almería, Spain
[2]Department of Automatic Control, Lund University, Box 118, SE-22100 Lund, Sweden

This paper presents a solution to the saturation problem in cascade control schemes. When cascade control approaches work in linear mode without saturation influence, important improvements can be achieved in industrial control loops. The effect of disturbances and/or nonlinear actuator behaviours on the main process variables can be considerably reduced. However, when saturation arises in the inner loop, these improvements cannot be reached and even sometimes the saturated cascade control scheme gives worse results than a single control loop. Thus, this work analyzes this situation and introduces a very simple solution to solve this problem and to reduce the impact of the saturation effect.

July,1
12:05
Control Theory I

A state-space model inversion control method for shake table systems

José Ramírez-Senent[1], Jaime H. García-Palacios[1] and Iván M. Díaz[1]

[1]Escuela Técnica Superior de Ingenieros de Caminos, Canales y Puertos, Universidad Politécnica de Madrid, Madrid, 28040, Spain

Shake tables used to perform laboratory dynamic testing of structures are com-monly powered by hydraulic servoactuators. Due to the inherent non-linearity of servohydraulic systems, advanced control algorithms are required to achieve ac-curate reference tracking. Traditionally, these algorithms have been based on es-timating, at a first stage, the Frequency Response Function of the system and in-verting it to yield the Impedance Function. The Impedance is then operated with the desired system output and the result transformed into time domain to obtain an initial estimate of the drive to be fed to the system. This estimate is improved during the test in an iterative fashion. One of the main drawbacks of this ap-proach is the fact that references which are not known beforehand and change in real time, cannot be directly addressed. In this work, a control method based on the inversion of a state-space model of the servo-actuator is presented. First off, a non-linear model of the testing system is developed. Next, a Feedback Lineariza-tion procedure to minimize servovalve non linearities is explained and the state-space identification procedure is described. Then, the model inversion method is addressed, together with the state variables estimator required to perform real time control. Finally, the simulation results obtained are discussed. The suggested method shows an excellent performance in numerical experiments; nevertheless, further studies must be undertaken to ensure its successful implementation in ac-tual shake table systems.

July,1
15:05
Control Engineering and Industrial Automation Education

Your turn to learn! – Flipped Classroom in Automation Courses

Filomena Soares[1], P.B. de Moura Oliveira[2,3] and Celina P. Leão[1]

[1]Centro Algoritmi, Engineering School, University of Minho, 4800-058 Guimarães, Portugal
[2]UTAD-University of Trás-os-Montes and Alto Douro, ECT, 5000-801 Vila Real, Portugal
[3]INESC TEC Technology and Science, Campus da FEUP, 4200 - 465 Porto, Portugal

Flipped Classroom approach was implemented in an Automation course with around 100 students. Videos focused on Grafcet topics were given to students prior to class and problem-based challenges were solved in class by the students in a collaborative way. The teacher's role was to guide students in their learning process. The goal was to identify students' behavior regarding this learning ap-proach, and the videos in particular, by using questionnaires. Result analysis shows a positive feedback from students motivating teachers to enlarge this learn-ing approach to other courses.

Concepts of threshold assessment for a first course in control engineering

July,1
15:25
Control Engineering and
Industrial Automation
Education

John Anthony Rossiter[1]

[1]Dept. of Automatic Control and Systems Eng., University of Sheffield, UK

This paper focuses on the combined challenge of encouraging students to engage with learning and assessment of their competence levels. A core challenge for many staff is the need to distinguish different levels of learning, and to evidence core competence clearly, especially for students with lower marks. This paper proposes a novel assessment strategy which separates core competencies from the more challenging application of the learning in engineering problem solving. The assessment design is efficient for staff and students and allows a reduction in student stress levels while simultaneously giving them strong incentives to adopt good working practices. Evaluation evidence is given to demonstrate the efficacy of the approach.

Bridging Theory to Practice: Feedforward and Cascade Control with TCLab Arduino Kit

July,1
15:45
Control Engineering and
Industrial Automation
Education

P. B. de Moura Oliveira[1,2], John D. Hedengren [3] and J. Boaventura Cunha[1,2]

[1]INESC-TEC Technology and Science, Campus da FEUP, Porto
[2]University of Trás-os-Montes and Alto Douro (UTAD), Vila Real, Portugal
[3] Department of Chemical Engineering, Brigham Young University, Provo, UT, USA

Practice is of the essence in Engineering courses. A relevant question in control engineering education is: How to close the gap between theory and prac-tice? Once subjects are introduced in theoretical classes, students want to know about its practical use. Thus, it is important to introduce theoretical control concepts with practical experiments, enabling students to easily test and validate the theory. An Arduino based temperature control laboratory (TCLab) is deployed in this study as a portable kit providing students with a simple and effective means to test some feedback control techniques. Teach-ing/learning experiments are proposed involving proportional, integral and derivative controllers with Feedforward and Cascade control structures. Pre-liminary results achieved in a Portuguese university are presented.

Prototyping and Control of a Conveyor Belt: An educational Experiment in Mechatronics

July,1
16:05
Control Engineering and Industrial Automation Education

J. Gonçalves[1], J. Ribeiro[2] and P. Costa[3]

[1]Research Centre in Digitalization and Intelligent Robotics (CeDRI), Instituto Politécnico de Bragança, Campus de Santa Apolónia, 5300-253 Bragança, Portugal
[2]Instituto Politécnico de Bragança & CIMO, Portugal
[3]FEUP and INESC-TEC

In this paper it is presented an educational experiment, that consists of a mechatronic system applied to demonstrate concepts such as prototyping and control. The described mechatronic system is based on a conveyor belt, that was integrated with a manipulator, being physical devices commonly used in the industry. The conveyor Belt was prototyped from scratch, using 3d print technology. Its movement is based on the closed loop control of a DC Motor, based on a PID. The Conveyor Belt was integrated with a Braccio Manipulator from Arduino, using the ZMQ communication library, which is a high-performance asynchronous messaging library.

Teaching Neural Control with an Arduino Based Control Kit

July,1
16:25
Control Engineering and Industrial Automation Education

Ramiro S. Barbosa[1]

[1]GECAD - Research Group on Intelligent Engineering and Computing for Advanced Innovation and Development Institute of Engineering – Polytechnic of Porto (ISEP/IPP) Dept. of Electrical Engineering, Porto, Portugal

This paper presents an Arduino based control kit used to reinforce con-cepts on neural networks. The kit is used in the Unit Course (UC) of Advanced Control Systems (SISCA) taught at Institute of Engineering of Polytechnic of Porto (ISEP/IPP). It describes some experiments regarding modeling, identifica-tion and control using neural networks. The education control kit proved to be a useful tool to consolidate the theoretical concepts as well to make the classes more interesting, participatory and motivating for students.

Trajectory planning for landing with a direct optimal control algorithm

July,1
16:45
Control Engineering and Industrial Automation Education

Bertinho A. Costa[1] and Jo˜ao M. Lemos[2]

[1]INESC-ID IST ULisbon, Rua Alves Redol, 9 1000-029 Lisboa, Portugal

This article describes a methodology to introduce undergraduate students to the topic of optimal trajectory planning, which is important topic for several fields such as robotics, aerospace, energy management, economics. To motivate the problem a spacecraft landing maneuver is consider where the trajectory is constrained by the initial and the final states and by saturation values on manipulated variables. An analysis of the dynamic model is performed to simplify the application of the optimization method. The model is discretized and state predictors are build that describe the relation between the initial state, the final state and the manipulated variables. This approach is a direct method one of the methods that is used in optimal control. Unconstrained optimization is used iteratively to compute the control actions and to adjust the weighting factors to progressively fulfill constraints.

An approach to model validation for Model Predictive Control based on Dvurecenska's metrics

July,1
15:05
Predictive Control

Victor D. Reyes Dreke[1], Manuel A. Pérez Serrano[1] and Claudio Garcia1[1]

[1]Escola Politécnica of the University of São Paulo, São Paulo, SP, Brazil

In this paper, Dvurecenska's validation metrics is proposed as a criterion for selecting a suitable model to be used by a Dynamic Matrix Control (DMC) algorithm. As part of the work developed in this paper, it is analyzed how the DMC algorithm performs when using different models. Besides, a comparison between the validation of these model results is performed. Additionally to the above metrics, the FIT index and the Theil Inequality Coefficient index are employed too. This paper was developed on a simulated plant based on Clarke's benchmark, which is controlled with a DMC. As a result, it can be seen that Dvurecenska's metrics accomplishes its objective and in some cases, gives better validation criteria than the other metrics analyzed.

Distributed Adaptive Predictive Control Based on Switched Multiple Models and ADMM

July,1
15:25
Predictive Control

Margarida Nabais[1] and João M. Lemos[1]

[1]INESC-ID, IST, Univ Lisboa

This article presents a novel distributed adaptive predictive controller based on supervised multiple models. The local control agents embbed a linear model based predictive control (MPC) algorithm and a coordination algorithm that relies on the Alternating Direction Method of Multipliers (ADMM) distributed optimization algorithm. In order to illustrate the controller proposed, this one is applied to the coordinated control of steam flow and pressure in a biomass thermal power plant. A comparison is made with two other distributed adaptive controllers, with coordination based on a game procedure, one with LQG, and the other with local MPC controllers.

Optimization of the clinker production phase in a cement plant

July,1
15:45
Predictive Control

Silvia Maria Zanoli[1], Lorenzo Orlietti[2], Francesco Cocchioni[2], Giacomo Astolfi[2] and Crescenzo Pepe[2]

[1]Università Politecnica delle Marche, Via Brecce Bianche 12, 60131 Ancona (AN), Italy
[2]Alperia Bartucci S.p.A., Corso Vittorio Emanuele II, 37038 Soave (VR), Italy

In this paper, the control and the optimization of the clinker production phase of an Italian dry cement industry is described. A tailored Advanced Process Control architecture has been proposed, based on a two-layer Model Predictive Control strategy. The critical process variables have been included in the controller setup through linear models with delays. The controller moves are computed through two subsequent constrained optimization prob-lems with cooperation and consistency assumptions. The developed control-ler replaced a previous control system based on plant operators' manual conduction. Thanks to the multivariable and predictive approach, more prof-itable operating points have been guaranteed for the process, significantly improving the process control performances. In this way, the energy con-sumption and the environmental emissions have been reduced, taking into account quality and production requirements.

Model Predictive Control of a pusher type reheating furnace

July,1
16:05
Predictive Control

Silvia Maria Zanoli[1], Francesco Cocchioni[2], Chiara Valzecchi[2] and Crescenzo Pepe[2]

[1]Università Politecnica delle Marche, Via Brecce Bianche 12, 60131 Ancona (AN), Italy
[2]Alperia Bartucci S.p.A., Corso Vittorio Emanuele II, 37038 Soave (VR), Italy

This paper focuses on the design of an Advanced Process Control system for the control and the optimization of a pusher type billets reheating furnace. The controller formulation is based on a two-layer Model Predictive Control strategy. The formulated linear model of the furnace variables and the billets temperature behavior is constituted by a combination of Linear Time Invariant and Linear Parameter Varying models. The basic control mode is based on an adaptive approach. Simulation and field results on a plant located in an Italian steel industry have shown the reliability of the proposed control system and its optimality with respect to the previous control system, based on local PID controllers managed by plant operators. Significant improvements on process control have been obtained, together with a major and safer approach to process operating limits.

MPC Framework for Supply Chain Management Integrating On-time Delivery and Transport Management

July,1
16:25
Predictive Control

Eduardo Araújo[2], João Lemos Nabais[1,2] and Miguel Ayala Botto[2]

[1]School of Business Administration, Instituto Politécnico de Setúbal, Campus do IPS, Estefanilha, 2910-761 Setúbal, Portugal
[2]IDMEC, Instituto Superior Técnico, Universidade de Lisboa

Currently, there is a challenge in Supply Chain Management (SCM) which consists on the coordination of efforts to correspond to clients demands in the presence of conflicting goals of the various chain actors. On the one hand, suppliers, manufacturers, and retailers are interested in providing to customers the right product, in the right amount, at the right time, for the right price, and at the right place. On the other hand, transport providers (TP) want to efficiently allocate their fleets and minimise the number of movements. To solve the trade-off between (i) on-time delivery, and (ii) efficient transportation management, this work presents a novel dynamic approach for real-time SCM integrating transportation operations, based on a model predictive control framework. Focusing on the discrete time case, a flow perspective is taken in which the material flow is decomposed into flow of goods and flow of transportation vehicles to model the conflicting views of the various actors. The framework performance is illustrated with simulation studies considering two-echelon vertical integrated chain with manufacturing.

Fractional Order Predictive Control for Trajectory Tracking of the AR.Drone Quadrotor

July,1
16:45
Predictive Control

Ricardo Cajo[1,2,3], Shiquan Zhao[1,4], Douglas Plaza[3], Robain De Keyser[1,2], Clara Ionescu[1,2,5]

[1]Ghent University, Department of Electromechanical, Systems and Metal Engineering, Tech Lane Science Park 125, Ghent B-9052, Belgium
[2]Flanders Make, EEDT Decision & Control, Ghent B-9052, Belgium
[3]Escuela Superior Politécnica del Litoral ESPOL, Campus Gustavo Galindo km 30.5 Via Perimetral, P.O. Box 09-01-5863 Guayaquil, Ecuador
[4]Harbin Engineering University, College of Automation, Harbin 150001, China
[5]Technical University of Cluj-Napoca, Department of Automation, Memorandumului Street No.28, Cluj-Napoca 400114, Romania

A fractional-order model predictive control with extended prediction self-adaptive control (FOMPC-EPSAC) strategy is proposed for the AR.Drone quadrotor system. The objective is to achieve an optimal trajectory tracking control for an AR.Drone quadrotor by using a fractional order integral cost function in the conventional MPC-EPSAC algorithm. In addition, a particle swarm optimization (PSO) algorithm is applied to nd the optimal weighting matrices, which depend on the terms (alpha,beta) of the fractional order cost function. Some simulation results show the superiority of FOMPC-EPSAC over conventional MPC-EPSAC with respect to trajectory tracking and robustness under wind disturbances.

Temperature Control on Double-Pipe Heat-Exchangers: an application

July,1
17:25
PID Control : Tuning, Design and Applications

S.J. Costa[1], R. Ferreira[2] and J.M. Igreja[3]

[1]ISEL-IPL, R. Conselheiro Emídio Navarro, 1, Lisboa, Portugal
[2]ISEL-IPL and IST-ULisboa, Lisboa, Portugal
[3]ISEL-IPL and INESC-ID, Lisboa, Portugal

This paper describes mathematical models of heat-exchangers and a control application for a laboratory dual mode (co-current or counter-current) heat-exchanger apparatus. In particular, the co-current and counter-current transfer functions are obtained from the partial differential equations (PDE) that describes the heat equations for both cold and hot uid travelling in the pipes. Pole and zeros maps are also obtained for further dynamical analysis. A PID solution for the control of a laboratory apparatus that can work in both co- and counter-current mode is explained and some results are presented.

Differential Observation and Integral Action in LTI State-Space Controllers and the PID Special Case

July,1
17:45
PID Control : Tuning,
Design and Applications

Paulo Garrido[1,2]

[1]CAR RG, Algoritmi Center, Guimarães, Portugal
[2]LIAAD, INESC TEC, Porto, Portugal

This paper makes the case that practical differentiation of measured state variables may be seen as an observation or estimation scheme for linear time invariant state space controllers. It is shown that although not having the separation property, the estimation error of this scheme – differential observation – converges to zero if the resulting closed loop system is strictly stable. On the basis of this concept, it is shown that PID controllers may be interpreted as a special case of state space controllers endowed with differential observation.

Robustness issues in Event-Based PI control systems: Internal Model Control tuning

July,1
18:05
PID Control : Tuning,
Design and Applications

R. Vilanova[1], C. Pedret[1], M. Barbu[2], M. Beschi[3], A. Visioli[3]

[1]Universitat Autónoma de Barcelona, Spain
[2]"Dunarea de Jos" Univerity of Galati, Romania
[3]University of Brescia, Italy

Event-based solutions for process control applications are of clear increasing interest. The approach is really appealing because of clear advantages for what matters to minimal use of communication bandwidth, energy consumption, etc. Therefore, completely appropriate for the wireless sensor-actuator networks. One of the solutions that, at least within the process control domain, has reached more acceptance is that of event-based control on the basis of a Simmetric-Send-on-Delta (SSOD) event detector. In this work, a specific implementation of this smart sensor is proposed with clear advantages with respect to the usual ones. The major advantage is that the resulting event-based control system has better robustness properties than the usual implementation that is found in the literature.

Practical Validation of a Dual Mode Feedforward-Feedback Control Scheme in an Arduino Kit

July,1
18:25
PID Control : Tuning, Design and Applications

P. B. de Moura Oliveira[1] and Damir Vrančić[1]

[1]INESC-TEC Technology and Science, Campus da FEUP, Porto, Department of Engineering, University of Trás-os-Montes and Alto Douro (UTAD), Vila Real, Portugal
[2]Department of Systems and Control, Jožef Stefan Institute, Jamova cesta 39, Ljubljana, Slovenia

Two major control design objectives are set-point tracking and disturbance rejection. How to design a control system to achieve the best possible per-formance for both objectives is a classical research issue. For most systems these design objectives are conflicting meaning that a single controller can-not cope in providing overall good performance. In this paper, a dual mode control system is reported using a feedforward controller to achieve optimum set-point tracking and PID control to deal with disturbance rejection. A par-ticle swarm optimization algorithm is deployed to design the feedforward controller and the magnitude optimum multiple integration method applied to design the PI/PID controllers. The proposed control system is tested on a custom-made laboratory control temperature kit based on Arduino system. Preliminary results are presented showing the dual-mode control potential merits.

Addendum to "Seeking a unique view to control of simple systems"

July,1
18:45
PID Control : Tuning, Design and Applications

M. Huba1[1], M. Hypiusová[1], P. Tapák[1] and A. Serbezov[2]

[1]Slovak University of Technology in Bratislava, 812 19 Bratislava, Slovakia
[1]Rose-Hulman Institute of Technology, Terre Haute, IN 47803, USA

This article extends spectrum of basic structures with disturbance reconstruction and compensation considered in the original paper presented at IFAC ACE'19 symposium and discusses problems met in their application, interpretation and education. It is preferably focussed on developing understanding of basic control problems wrapped arround the simplest plant models, which may be useful in dealing with their generalization to more complex tasks. Reactions to some comments received are also included and responded.

An IIoT Solution for SME's

July,1
17:25
Automation

Bruno Cunha[1], Elder Hernández[1], Rui Rebelo[1], Cristóvão Sousa[1,2], Filipe Ferreira[1]

[1]INESC TEC, Porto, 4200-465, Portugal
[2]CIICESI-ESTG, Politécnico do Porto, Felgueiras, 4610-156, Portugal

The innovation and digitalization of the industry is happening triggered by the Industry 4.0 and Industrial Internet-of-Things (IIoT) paradigm. Enterprises are following the trend of digital transformation and are fostering projects that enable a higher comprehension of I4.0 solutions to answer their needs. The IIoT platforms have been a central component for industrial systems architectures to enable interoperability and data flow within industrial settings. However, the digitalization process has all sorts of shortcomings associated to them, and in the SME's this transformation has been slow to none. In this work we showcase a proof of concept of an IIoT platform that intends to simplify the digitalization process in SME's, based on the Portuguese footwear industry cluster.

Home Energy Management System in an Algarve residence. First results

July,1
17:45
Automation

A. Ruano[1,2], K. Bot[1] and M. Graça Ruano[1,3]

[1]CINTAL, Universidade do Algarve, 8005, Faro, Portugal
[2]IDMEC; Instituto Superior Técnico, Universidade de Lisboa, Lisboa, Portugal
[3]CISUC, University of Coimbra, Coimbra, Portugal

Home Energy Management Systems (HEMS) are becoming increasingly re-searched to invert the continuously increasing trend in (electrical) energy con-sumption in buildings. One of the key aspects of any HEMS is the real-time monitoring of all variables related with the management system, as well as the re-al-time control of schedulable electric appliances. This paper describes a data ac-quisition system implemented in a residential house in the South of Portugal. With the small amount of data collected, a model to forecast total electric con-sumption was developed. Results show that, even with these small data, the mod-el can be used in a predictive control scheduling mechanism for HEMS.

Open Hardware and Software Robotics Competition for Additional Engagement in ECE Students - The Robot@Factory Lite Case Study

July,1
18:05
Automation

Vítor H. Pinto[1,3], Armando Sousa[1,3], José Lima[2], José Gonçalves[2] and Paulo Costa[1,3]

[1]FEUP - University of Porto, Faculty of Engineering, Porto, Portugal
[1]IPB - Polytechnic Institute of Bragança Bragança, Portugal
[1]INESC TEC - Institute for Systems and Computer Engineering, Technology and Science, CRIIS - Centre for Robotics in Industry and Intelligent Systems Porto, Portugal

Throughout this paper, a competition created to enable an inter-connection between the academic and industrial paradigms is presented, using Open Hardware and Software. This competition is called Robot at Factory Lite and serves asa case study as an additional enrolment for students to apply knowledge in the fields of programming, perception, motion planning, task planning, autonomous robotic, among others.

Engine Labels Detection for Vehicle Quality Verification in the Assembly Line: A Machine Vision Approach

July,1
18:25
Automation

Sílvio Capela[1], Rita Silva[1], Salik Ram Khanal[1], Ana Teresa Campaniço[1], João Barroso[1,2], Vítor Filipe[1,2]

[1]School of Science and Technology, Universidade de Trás-os-Montes e Alto Douro 5000-801, Vila Real, Portugal
[1]INESC TEC – Institute for Systems and Computer Engineering, Technology and Science, 4200-465, Porto, Portugal

The automotive industry has an extremely high-quality product standard, not just for the security risks each faulty component can present, but the very brand image it must uphold at all times to stay competitive. In this paper, a prototype model is proposed for smart quality inspection using machine vision. The engine levels are detected using Faster-RCNN and YOLOv3 object detection algorithms. All the experiments were carried out using a custom dataset collected at an automotive assembly plant. Eight engine labels of two brands (Citroën and Peugeot) and more than ten models were detected. The results were evaluated using the metrics Intersection of Union (IoU), mean of Average Precision (mAP), Confusion Matrix, Precision, and Recall. The results were validated in three folds. The models were trained using a custom dataset containing images and annotation files collected and prepared manually. Data Augmentation techniques were applied to increase image diversity. The result without data augmentation was 92.5%, and with it, the value was up to 100%. Faster-RCNN has more accurate results compared to YOLOv3.

Prototyping of a low-cost stroboscope to be applied in condition maintenance: An open hardware and software approach

July,1
18:45
Automation

Laiany Brancalião[1], Caio Camargo[1], José Gonçalves[2] and José Lima[2]

[1]Polytechnic Institute of Bragança, Bragança, Portugal
[2]Research Centre in Digitalization and Intelligent Robotics (CeDRI), Instituto Politécnico de Bragança, Campus de Santa Apolónia, 5300-253 Bragança, Portugal

This paper aims to describe the prototyping of a low-cost stroboscope, to be applied in condition maintenance, which consists of an optical equipment capable of generating flashes of light at different frequencies, allowing to measure the rotation velocity of machines and contributing to maintenance processes in the industry. This device is based on the stroboscopic effect, a visual event that occurs when a continuous movement is presented by a series of samples, generated by flashes of light. When the frequency of the rotation movement is the same frequency of light pulses, the process will appear stationary. Having as reference the high cost of the commercial stroboscopes, it was developed an Arduino basd stroboscope prototype, with LED technology and 3D printing, using an open hardware and software approach. The final prototype went through calibration and validation processes, achieving a performance very similar to a commercial instrument.

State-space estimation using the behavioral approach: a simple particular case

July,2
11:05
Nonlinear Data - Theory & Applications II

Lorenzo Ntogramatzidis[1], Ricardo Pereira[2] and Paula Rocha[3]

[1]Department of Mathematics and Statistics, Curtin University, Perth (WA), Australia
[2]CIDMA, Department of Mathematics, University of Aveiro, Portugal
[3]SYSTEC, Faculty of Engineering, University of Porto, Portugal

In this paper we apply the behavioral estimation theory to the particular case of state-space systems. We derive new necessary and sufficient conditions for the solvability of the estimation problem in the presence of disturbances, and provide a method to construct an estimator in case the problem is solvable.

Cubic splines in the Grassmann manifold

July,2
11:25
Nonlinear Data - Theory & Applications II

Fátima Pina[1,2] and Fátima Silva Leite[1,2]

[1]University of Coimbra, Department of Mathematics, 3001-501 Coimbra, Portugal
[1]Institute of Systems and Robotics, DEEC-UC, 3030-789 Coimbra, Portugal

We present a detailed implementation of the De Casteljau algorithm to generate cubic splines that solve certain interpolation problems on the Grassmann manifold.

An Extrinsic Approach to Sub-Riemannian Geodesics on the Orthogonal Group

July,2
11:45
Nonlinear Data - Theory & Applications II

Knut Hüeper[1], Irina Markina[2], and Fátima Silva Leite[3]

[1]Institute for Mathematics, Julius-Maximilians-Universität, Würzburg, Germany
[2]Mathematical Institute, University of Bergen, Norway
[3]University of Coimbra, Department of Mathematics, 3001-501 Coimbra and Institute of Systems and Robotics, DEEC-UC, 3030-789 Coimbra, Portugal

In this paper we use a variational approach, combining holonomic and nonholonomic constraints, to find an equation for sub-Riemannian geodesics on the orthogonal group. This approach is extrinsic in nature and makes the paper fully self-contained and possibly more accessible for a wide audience. The problem is formulated in the vector space of real square matrices, subject to two side conditions, and solved using a Langrange multiplier approach. The nonholonomic constraint corresponds to the requirement that the curves are tangent to a left-invariant distribution. This distribution is defined by the vector space that shows up in a Cartan decomposition of the Lie algebra associated to the orthogonal group.

Existence and uniqueness for Riemannian cubics

July,2
12:05
Nonlinear Data - Theory & Applications II

Margarida Camarinha[1], Fátima Silva Leite[2] and Peter Crouch[3]

[1]University of Coimbra, CMUC, Department of Mathematics, 3001-501 Coimbra, Portugal
[2]University of Coimbra, Department of Mathematics, 3001-501 Coimbra, Portugal and Institute of Systems and Robotics, DEEC-UC, 3030-789 Coimbra, Portugal
[3]Arlington College of Engineering, University of Texas at Arlington, Arlington, Texas, USA

We study local existence and uniqueness for Riemannian cubics satisfying boundary conditions. We define the biexponential map and use it to relate initial and boundary data. We also describe biconjugate points along cubics by means of the biexponential map.

Fallback Approximated Constrained Optimal Output Feedback Control under Variable Parameters

July,2
11:05
Control Theory II

Christian Kallies[1], Mohamed Ibrahim[1] and Rolf Findeisen[1]

[1]Laboratory for Systems Theory and Automatic Control, Otto von Guericke University, Magdeburg, Germany

Safety critical control problems often require the availability of fallback strategies, in case of failure of the main control scheme, sensors or actuators. Those controllers should provide safe operation or emergency shut down of the system under all circumstance. They should also be able to operate subject to reduced information, and limited computation power. We propose a veriable and eciently implementable output feedback controller based on an approximated explicit solution of a constrained optimal control problem. The control law is derived by solving an innite horizon optimal control problem utilizing Al-brekht's Method to obtain power series expansions. The feedback control law is a polynomial in terms of the measurements and estimated parameters, thus the online evaluation can be done eciently . We provide conditions for convergence and existence of the optimal control law and the corresponding value function. Simulation results for the control of a non-linear autonomous quadcopter example show the eectiveness of the proposed strategy.

Distributed LQ control of a water delivery canal based on a selfish game

July,2
11:25
Control Theory II

João P. Belfo[1], João M. Lemos[1] and A. Pedro Aguiar[2]

[1]INESC-ID, Instituto Superior Técnico, Lisboa, Portugal
[2]SYSTEC, Faculdade de Engenharia da Universidade do Porto, Porto, Portugal

This article describes the design of distributed LQ controllers based on a linear model of a water delivery canal. According to a distributed strategy, a local control agent is associated to each gate of the canal. The main goal is to control the position of the gates in order to drive the water levels for each pool to variable references. For this purpose, local optimization problems are presented, that will be solved at each local controller. In order to achieve a consensus between agents, a coordination method, based on game theory, is presented, including its convergence analysis. The overall controller architecture is described. Simulations, illustrating situations in which the convergence conditions are satisfied, are presented.

Stabilization using in-domain actuator: a numerical method for a non linear parabolic partial differential equation

July,2
11:45
Control Theory II

Thérèse Azar[1], Laetitia Perez[1], Christophe Prieur[2], Emmanuel Moulay[3] and Laurent Autrique[1]

[1]LARIS-Polytech, Angers, France
[2]Gipsa-Lab, Grenoble, France
[3]XLIM, Poitiers, France

This paper deals with the problem of null controllability for an unstable nonlinear parabolic partial differential equation (PDE) system considering in-domain actuator. The main objective of this communication is to provide an efficient control law in order to stabilize the system state close to zero in a desired time whatever the initial state is. A numerical approach is developed and in order to highlight the relevance of the proposed control strategy, a realistic physical problem is investigated. Thermal evolution of a thin rod with homogeneous Dirichlet boundaries conditions is considered. Thermal state is described by the heat equation and assuming that thermal conductivity is temperature dependent, a nonlinear mathematical model has to be taken into account. Considering that all the model inputs are known, a direct problem is numerically solved (considering a finite element method) in order to estimate the temperature at each point of the 1D geometry and at each instant. Then an inverse problem is formulated in such a way as to determine the in-domain control which ensure a final temperature close to zero. An iterative regularization method based on the conjugate gradient method (CGM) is developed for the minimization a quadratic cost function (output error). Several numerical experimentations are provided in order to discuss the numerical approach attractiveness.

Direct Power Control of a Doubly Fed Induction Generator Using a Lyapunov Based State Space Approach

July,2
12:05
Control Theory II

Yassine Boukili[1], A. Pedro Aguiar[1] and Adriano Carvalho[1]

[1]Department of Electrical and Computer Engineering, Faculty of Engineering, University of Porto (FEUP), Porto, Portugal

This paper addresses the modelling and control design of a Doubly-Fed Induction Generator (DFIG) when connected to a grid subject to unbalanced grid voltage conditions. Using Lyapunov theory, we derive a robust direct power control law that tracks the active and reactive power references that are adequately manipulated accordingly with the presence of unbalanced grid voltage dips. Simulation results illustrate the robustness and effectiveness of the proposed controller.

Performance Enhancement of a Neato XV-11 Laser Scanner Applied to Mobile Robot Localization: A Stochastic Modeling Approach

July,2
15:05
Control in Robotic Applications

J. Gonçalves[1], João Paulo Coelho[1], M. Braz-César[2] and P. Costa[3]

[1]Research Centre in Digitalization and Intelligent Robotics (CeDRI), Instituto Politécnico de Bragança, Campus de Santa Apolónia, 5300-253 Bragança, Portugal
[2]Instituto Politécnico de Bragança & CONSTRUCT R&D Unit, FEUP, Portugal
[3]FEUP and INESC-TEC

Laser scanners are widely used in mobile robotics localization systems but, despite the enormous potential of its use, their high price tag is a major drawback, mainly for hobbyist and educational robotics practitioners that usually have a reduced budget. The Neato XV-11 Laser Scanner is a very low cost alternative, when compared with the current available laser scanners, being this fact the main motivation for its use. The modeling of a hacked Neato XV-11 Laser Scanner allows to provide valuable information that can promote the development of better designs of robot localization systems based on this sensor. This paper presents, as an example, the performance enhancement of a Neato XV-11 Laser Scanner applied to mobile robot self-localization, being used as case study the Perfect Match Algorithm applied to the Robot@Factory competition.

Welding process automation of aluminum alloys for the transport industry: An Industrial Robotics Approach

July,2
15:25
Control in Robotic Applications

João Ribeiro[1], José Gonçalves[2] and Nuno Mineiro[3]

[1]CIMO & Instituto Politécnico de Bragança, Campus de Santa Apolónia, 5300-253 Bragança, Portugal
[2]Instituto Politécnico de Bragança & CeDRI, Portugal
[3]Roboplan, R. da Paz 292, 3800-587 Cacia, Portugal

The materials used in the transport industry have been changing in the last decades. The traditional and heavy steel have been switching by the light alloys like aluminum alloys. However, despite their advantages as low density and high corrosion resistance, the manufacturing process, especially fusion welding, is very demanding and challenging. In the transport industry, most of the hyperstatic components made in aluminum alloys are welded manually with the associate financial costs as well as the lack of quality and repeatability. For these reasons, it is urgent to develop new methodologies to automate this process. The present work intends to show a scientific method to automate the welding process of hyperstatic frames, very common in bicycles, made in aluminum alloy. This methodology involves two steps, the first one in which is performed numerical simulations to determine the optimal welding parameters to minimize the distortion and residual stresses. The second step is experimental one, and it is created an automated welding cell with a robot to weld the frames. It has been proved that it is possible to obtain welding aluminum frames with acceptable quality in agreement with the ASME IX standard.

A DOBOT Manipulator Simulation Environment for Teaching Aim with Forward and Inverse Kinematics

July,2
15:45
Control in Robotic Applications

Thadeu Brito[1], José Lima[1,2], João Braun[3], Luis Piardi[1] and Paulo Costa[2,4]

[1]Research Centre in Digitalization and Intelligent Robotics (CeDRI), Instituto Politécnico de Bragança, Campus de Santa Apolónia, 5300-253 Bragança, Portugal
[2]INESC TEC - INESC Technology and Science, Porto, Portugal
[3]Federal University of Technology - Paraná, Toledo, Brazil
[4]Faculty of Engineering of University of Porto, Porto, Portugal

Industrial Manipulators were becoming used more and more at industries since the third industrial revolution. Actually, with the fourth one, the paradigm is changing, and the collaborative robots are being accepted for the community. It means that smaller manipulators with more functionalities have been used and installed. New approaches have appeared to teach students according to the new robot's capabilities. The DOBOT robot is an example of that since it captivates the student's attention with an uncomplicated programming front-end, tools, grippers and extremely useful for teaching STEM. This paper proposes a simulation environment that can be used to teach, test and validate solutions to the DOBOT robot. By this way, the student can try and validate, at their homework without the real robot, the developed solutions and further test them at the laboratory with the real robot. Currently, remote testing and validation without the use of a real robot is an advantage. The comparison of the provided simulation environment and the real robot is presented in the approach.

Using Multi-UAV for Rescue Environment Mapping: Task Planning Optimization Approach

July,2
16:05
Control in Robotic Applications

Ricardo Rosa[1,5], Thadeu Brito[2], Ana I. Pereira[2,3], José Lima[2,4] and Marco A. Wehrmeister[5]

[1]Federal Institute of Education, Science and Technology - Paraná, Cascavel, Brazil
[2]Research Centre in Digitalization and Intelligent Robotics (CeDRI), Instituto Politécnico de Bragança, Campus de Santa Apolónia, 5300-253 Bragança, Portugal
[3]Algoritmi Center, University of Minho, 4710-057 Braga, Portugal
[4]INESC Technology and Science, Porto
[5]Federal University of Technology - Paraná (UTFPR), Curitiba, Brazil

The difficulty of rescuing people trapped in the rubble is usually due to the rescue teams being unaware of the environment or unable to identify where the survivors are. Using UAVs to map the environment, and also to get remote information, may benefit the rescue task as a whole. This work proposes a multi-UAVs planning system for indoor mapping environments that have been affected by a natural disaster. Such an approach is inspired by how the honey bees build their hive. Multiple UAVs navigate and explore the unstructured indoor environment in the same way the bees build a honeycomb. Thus, the various UAVs must explore coordinately to map the environment in the shortest time whereas travelling the smallest distance. Three strategies were evaluated in a simulation environment. The results indicate the feasibility of the proposed approach and point to an improvement in the environment mapping.

Extrinsic Sensor Calibration Methods for Mobile Robots: A Short Review

July,2
16:25
Control in Robotic Applications

Ricardo B. Sousa[1], Marcelo R. Petry[2] and António Paulo Moreira[1,2]

[1]Faculdade de Engenharia da Universidade do Porto, Porto, Portugal
[2]INESC TEC - Instituto de Engenharia de Sistemas e Computadores, Tecnologia e Ciência, Porto, Portugal

Data acquisition is a critical task for localisation and perception of mobile robots. It is necessary to compute the relative pose between onboard sensors to process the data in a common frame. Thus, extrinsic calibration computes the sensor's relative pose improving data consistency between them. This paper performs a literature review on extrinsic sensor calibration methods prioritising the most recent ones. The sensors types considered were laser scanners, cameras and IMUs. It was found methods for robot-laser, laser-laser, laser-camera, robot-camera, camera-camera, camera-IMU, IMU-IMU and laser-IMU calibration. The analysed methods allow the full calibration of a sensory system composed of lasers, cameras and IMUs.

Dynamic Model for the pH in a Raceway Reactor using Deep Learning techniques

July,2
15:05
Soft Computing Applied to Control

Pablo Otálora[1], José Luis Guzmán[1], Manuel Berenguel[1], Francisco Gabriel Acién[2]

[1]Department of Informatics, University of Almería, Ctra. Sacramento s/n,ceiA3, CIESOL, 04120 Almería, España
[2]Department of Chemical Engineering, University of Almería, Ctra. Sacramento s/n,ceiA3, CIESOL, 04120 Almería, España

This paper presents a black-box dynamic model for microalgae production in raceway reactors. The black-box model, developed using Deep Learning techniques, allows the estimation of the pH in a 100 m2 raceway reactor. The model has been created using only and exclusively data, what gives a high ease of use. The results obtained verify the effectiveness of this type of techniques for the modelling of complex dynamic processes. The model was validated for different weather conditions obtaining satisfactory results. Thus, the obtained model is fairly useful for simulation purposes or for the implementation of model-based control techniques.

July,2
15:25
Soft Computing Applied to Control

A Fuzzy based model to assess the influence of project risk on corporate behavior

Ricardo Santos[1,2], António Abreu[2,3], J.M.F. Calado[2,4], José Miguel Soares[5], José Duarte Moleiro Martins[6] and Vitor Anes[2,4]

[1]GOVCOPP - University of Aveiro, Portugal
[2]ISEL- Instituto Superior de Engenharia de Lisboa, Instituto Politécnico de Lisboa
[3]CTS Uninova, Faculdade de Ciências e Tecnologia, Universidade Nova de Lisboa, Portugal
[4]IDMEC-IST-UL, Lisboa, Portugal
[5]ADVANCE - Centro de Investigação Avançada em Gestão do ISEG ISEG - Lisbon School of Economics and Management, Universidade de Lisboa, Portugal
[6]ISCAL - Instituto Politécnico de Lisboa (ISCAL), Instituto Universitário de Lisboa (ISCTE-IUL), Business Research Unit (BRU-IUL), Lisboa, Portugal

Nowadays, the competitiveness on industry, requires a good preparation from the organizations, considering all events that may occur, which brings new challeng-es for the corporation's management. To address such challenges, risk manage-ment's models have been used to give a sense of threat prevention, by assessing each project's risk and the risk from the corporation itself as well. However, such models are normally based on human perception, which brings some subjectivity around the risks involved, making their definition less accurate. Additionally, there is a lack of models that allows to better define the corpora-tion's risk, by exploring the influence from the risk's project. To address these issues, this paper presents an approach, supported by fuzzy log-ic, to analyze the risk's level in an organization, by considering the influence of their projects. A case study will be used to assess the model robustness and to discuss the benefits and challenges found.

July,2
15:45
Soft Computing Applied to Control

Decentralized Control for Multi-Agent Missions based on Flocking Rules

Rafael Ribeiro[1], Daniel Silvestre[2] and Carlos Silvestre[2]

[1]Instituto Superior Técnico, Universidade de Lisboa, Lisbon, Portugal
[2]Department of Electrical and Computer Engineering of the Faculty of Science and Technology of the University of Macau, Macau, China

This paper addresses the problem of having a multi-agent system converging to multiple dynamic rendezvous areas for networks of agents with no localization sensors and limited communication capabilities. The localization is performed by measurement/communication towers that determine the noisy position and velocity of each relevant agent and transmit them using a directional antenna. There is no assumption on the connectedness of the network topology, which is unknown to all agents. The proposed solution consists of an improved flocking-based movement algorithm tailored to the proposed scenario, with mechanisms to prevent collisions. The performance of the solution is presented through multiple simulations for a multitude of environments. By an appropriate selection of an utility function, these empirical results hint to the possibility of realizing different types of missions intended for multi-agent systems using swarm behavior.

Classification of Car Parts using Deep Neural Network

July,2
16:05
Soft Computing Applied to Control

Salik Ram Khanal[1], Eurico Vasco Amorim[1,2] and Vitor Filipe[1,2]

[1]School of Science and Technology, Universidade de Trás-os-Montes e Alto Douro 5000-801, Vila Real, Portugal
[2]INESC TEC – Institute for Systems and Computer Engineering, Technology and Science 4200-465, Porto, Portugal

Quality automobile inspection is one of the critical application areas to achieve better quality at low cost and can be obtained with the advance computer vision technology. Whether for the quality inspection or the automatic assembly of automobile parts, automatic recognition of automobile parts plays an important role. In this article, vehicle parts are classified using deep neural network architecture designed based on ConvNet. The public dataset available in CompCars [1] were used to train and test a VGG16 deep learning architecture with a fully connected output layer of 8 neurons. The dataset has 20,439 RGB images of eight interior and exterior car parts taken from the front view. The dataset was first separated for training and testing purposes, and again training dataset was divided into training and validation purposes. The architecture was trained in 50 epochs with a batch size of 32. The average accuracy of 93.75% and the highest accuracy of 97.2% of individual parts recognition were obtained.

Control of bio-inspired multi-robots through gestures using convolutional neural networks in simulated environment

July,2
16:25
Soft Computing Applied to Control

A.A. Saraiva[2,6], D.B.S. Santos[1], N.M. Fonseca Ferreira[3,4,5] and J. Boaventura-Cunha[2,5]

[1]UESPI-University of State Piaui, Piripiri, Brazil
[2]University of Trás-os-Montes and Alto Douro,Vila Real, Portugal
[3]Coimbra Polytechnic - ISEC, Coimbra, Portugal
[4]Knowledge Engineering and Decision-Support Research Center (GECAD) of the Institute of Engineering, Polytechnic Institute of Porto
[5]INESC-TEC Technology and Science, Porto, Portugal
[6]University of Sao Paulo Sao Carlos - Brazil

In this paper the comparison between three convolutional neural networks, used for the control of bio-inspired multi-robots in a simulated environment, is performed through manual gestures captured in real time by a webcam. The neural networks are: VGG19, GoogLeNet and Alexnet. For the training of networks and control of robots, six gestures were used, each gesture corresponding to one action, collective and individual actions were defined, the simulation contains four bio-inspired robots. In this work the performance of the networks in the classification of gestures to control robots is compared. They proved to be efficient in the classification and control of agents, with Alexnet achieving an accuracy of 98.33%, VGG19 98.06% e Googlelenet 96.94%.

Study on the isolator-structure interaction. Influence on the supporting structure

July,2
17:25
Control of Smart Structures

J. Pérez-Aracil[1], E. Pereira[2], I. M. Díaz[3] and P. Reynolds[1]

[1]Vibration Engineering Section,College of Engineering, Mathematics and Physical Sciences, North Park Road, Exeter EX4 4PY, United Kingdom,
[2]Department of Signal Processing and Communications, Universidad de Alcalá, ES 28805, Alcalá de Henares, Madrid, Spain
[3]E.T.S. Ingenieros de Caminos, Canales y Puertos, Universidad Politécnica de Madrid, ES 28040, Madrid, Spain

Vibration isolation techniques allow to reduce the base movement transmitted to the platform to be isolated. There are different techniques that can be applied, but in most scenarios, the most suitable control system is active vibration isolation. This implies to apply an active force on the platform, and hence on the supporting structure. Some applications can consider the base structure as an infinitely rigid system, however the possibility of developing different task on the supporting structure such as: human activities or different isolators, lead to study how the active vibration isolation affects the base response. In this work, the general vibration isolation scenario is presented and the influence of the active vibration isolation on the supporting structure response is analysed and compared with the effect of the passive vibration isolation technique.

A comparative performance study of inertial vibration controllers for an ultra-lightweight GFRP footbridge

July,2
17:45
Control of Smart Structures

C.M.C. Renedo[1], J.M. Soria[1], C. Gallegos[1], Iván M. Díaz[1] and J. Jiménez-Alonso[1]

[1]ETSICCP, Universidad Politécnica de Madrid, 28040, Spain

Currently, the use of advanced lightweight materials in construction (as aluminum or fiber-reinforced polymer (FRP) composites) are enabling to create aesthetically pleasing structural forms through reducing their weight as much as possible. The results of this are ultra-lightweight structures (usually with low mass and inherent damping) which difficultly comply with the vibration serviceability limit state (VSLS) under human-induced dynamic loading. Moreover, when assessing VSLS, the existing human-structure interaction (HIS) should be considered as it tends to be remarkable. Hence, smart damping strategies can be seen as a good solution to preserve the lightweight nature of these structures in the most efficient way. This work aims to investigate whether the efficiency of three types of inertial controllers applied to an ultralightweight FRP footbridge degrades or not when considering the HSI as another inherent element of the dynamic system to be controlled.

Mitigation of earthquake-induced structural pounding between adjoining buildings – State-of-the-art

Pedro Folhento[1], Rui Barros[1] and Manuel Braz-César[2]

[1]Faculty of Engineering of the University of Porto
[2]Polytechnic Institute of Bragança

The investigation of collisions between contiguous building structures due to severe earthquakes is of great importance, particularly in large cities where there is a high population density. These collisions will produce strong impact forces that will significantly influence the dynamic behavior of building structures. Moreover, these impacts may provoke serious structural damage, that can lead to local collapse, or in the worst-case scenario to complete structural collapse. Different measures and techniques in mitigating pounding effects between adjacent buildings during seismic hazard events were extensively developed and studied by several researchers in recent years. This study presents an overview of these different pounding mitigation solutions, namely regarding the required separation seismic gap, link elements, shock absorber devices, structure stiffening, and supplemental energy and control devices. The main conclusions of several researches, from pioneer to state-of-the-art studies, concerning code provisions for minimum gap sizes and solutions for pounding mitigation between buildings, are compiled and presented in this study to demonstrate its diversity, effectiveness and practical applications.

Dynamic Survey of a Telecommunication Tower by Interferometric Radar Technique

F. Paiva[1], R.C. Barros[2], J. Henriques[3], T. Cunha[3], P. Feyfant[4]

[1]Instituto Superior Técnico, University of Lisbon, Portugal
[2]Faculty of Engineering, University of Porto, Porto, Portugal
[3]BSSE, Porto, Portugal
[4]ITAS Pylônes, France

The dynamic behavior (in terms of resonant frequencies and modal damping ratios) of a Telecommunication Tower located in France is studied using an Interferometric Radar (IR). The tower under investigation suffers from a dynamic instability phenomenon, designated as vortex shedding that induce large lateral vibration on the tower. As a possible solution for vortex shedding phenomena a Tuned Liquid Damper (TLD) device was developed and installed, with the purpose of mitigating the vibrations by adding damping into the system. From the investigation conducted and with the help of modal identification techniques in the frequency and time domain, some conclusions can be drawn in terms of modal estimation parameters for the Telecommunication Tower before and after TLD implementation. In both the TLD stages it was possible to identify the frequencies for the first two global modes of the tower, with a positive degree of certainty. The same statement cannot be asserted for the modal damping ratio. The time domain technique (SSI-UPC method), applied in this work to estimate the damping ratio, has displayed a high variability. Factors like duration of the measurements, number of output sensors considered, spectral range and others related with specific parameters of the method, affected significantly the values achieved. The weak ambient excitation during the dynamic survey also limited the reliability of the modal damping ratio estimates. The TLD implementation affected the structure in two ways: by reducing the first frequency from 0.960 Hz to 0.823 Hz; and through the increased energy dissipation in the system, where a more evident effect in the structure first mode was also detected.

Motion-based Design of Semi-Active Tuned Mass Dampers to Control Pedestrian-Induced Vibrations in Footbridges under Uncertainty Conditions

Javier Fernando Jiménez-Alonso[1], José Manuel Soria Herrera[1], Carlos Martín de la Concha Renedo[1] and Francisco Guillen-González[2]

[1]Escuela Técnica Superior de Ingenieros de Caminos, Canales y Puertos. Universidad Politécnica de Madrid, Madrid 28040, Spain
[2]Facultad de Matemáticas. Universidad de Sevilla, Sevilla 41012, Spain

Modern slender footbridges are sensitive to pedestrian-induced vibrations together with the uncertainty associated with the variation of the operational and environmental conditions. In order to overcome these limitations, semi-active damping devices have been widely employed due to their adequate balancebetween their effectiveness and their cost when they are used to control the pedestrian-induced vibrations in footbridges. Different design methods have been proposed to guarantee that the footbridges, controlled by these damping devices, meet the vibration serviceability limit state without compromising their budget. Among these proposals, the motion-based design method has shown a high performance when it has been implemented to design passive damping devices for footbridges. Herein, the motion-based design method under uncertainty conditions has been adapted and further implemented for the robust optimum design of semi-active tuned mass dampers when they are employed to control the pedestrian-induced vibrations in slender footbridges. According to this method, the design problem can be transformed into two sub-problems: (i) a multi-objective optimization sub-problem; and (ii) a reliability analysis sub-problem. Thus, its main objective is to find the parameters of the semi-active damping device which guarantee an adequate comfort level without compromising its cost. In order to take into account the effect of the modification of the structural modal properties associated with the variation of the operational and environmental conditions, thecompliance of the design requirements has been formulated via a reliability index. Therefore, a reliability analysis must be performed to assess the probability of failure associated with the abovementioned serviceability limit state.

July,2
17:25
Robotics

Cooperative circumnavigation for a mobile target using adaptive estimation

Joana Fonseca[1], Jieqiang Wei[2], Tor A. Johansen[3], and Karl H. Johansson[1]

[1]KTH Royal Institute of Technology, Stockholm, Sweden
[2]Ericsson, Stockholm, Sweden
[3]Norwegian University of Science and Technology, Trondheim, Norway

In this paper we consider the problem of tracking a mobile target using adaptive estimation while circumnavigating it with a system of Unmanned Surface Vehicles (USVs). The mobile target considered is an irregular dynamic shape approximated by a circle with moving centre and varying radius. The USV system is composed of n USVs of which one is equipped with an Unmanned Aerial Vehicle (UAV) capable of measuring both the distance to the boundary of the target and to its centre. This USV equipped with the UAV uses adaptive estimation to calculate the location and size of the mobile target. The USV system must circumnavigate the boundary of the target while forming a regular polygon. We design two algorithms: One for the adaptive estimation of the target using the UAV's measurements and another for the control protocol to be applied by all USVs in their navigation. The convergence of both algorithms to the desired state is proved up to a limit bound. Two simulated examples are provided to verify the performance of the algorithms designed in this paper.

July,2
17:45
Robotics

Cloud-Based Framework for Robot operation in Hospital Environments

NM Fonseca Ferreira[1] and J. Boaventura-Cunha[2,3]

[1]Coimbra Polytechnic – ISEC, Portugal
[2]University of Trás-os-Montes and Alto Douro, Vila Real, Portugal
[3]INESC TEC – Campus da FEUP, Porto, Portugal

The robotics field is widely used in the industrial domain, but nowadays several other domains could also take advantage of it. This interdisciplinary branch of engineering requires the use of human interfaces, efficient communication systems, high storage and processing capabilities, among other issues, to perform complex tasks. This paper aims to propose a cloud-based framework platform for robot operation in a hospital environment, addressing some challenges, such as communications security and processing/storage features. The recent developments in the artificial intelligence field and cloud resources sharing are allowing the penetration of robots in unstructured environments. However, some new challenges and solutions need to be tested in real environments. Our main contribution is to decrease the time-consumption related to processing and storage costs, associated with the physical processing resources of the robots. Also, the proposed methods provide an increase of the processing variables that are not yet present in the physical resources, such as in the case of robots with limited processing time or storage capabilities. This paper presents a platform based on Cloud Computing with services to support processing, storage and analytics applied to hospital environments. The proposed platform enables to achieve a decrease in the time-consumption, especially when it is intended to retrieve information about all robot activities.

On the Use of a Maximum Correntropy Criterion in Kalman Filtering Based Strategies for Robot Localization and Mapping

July,2
18:05
Robotics

Matheus F. Reis[1], Hamed Moayyed[1] and A. Pedro Aguiar[1]

[1]Department of Electrical and Computer Engineering Faculty of Engineering, University of Porto

One of the applications of the Kalman filter in the field of robotics is to solve the problem of Simultaneous Localization and Mapping (SLAM). The main drawback of the Kalman filter is that its performance can degrade in the presence of non-Gaussian measurement noise. In robotic systems using laser range finders such as the LiDAR, often optical properties of the beam-environment interaction introduce non-Gaussian noise into the system, which can significantly affect performance. In this paper, we investigate this problem and propose a SLAM algorithm using an Extended Kalman filter based on the Maximum Correntropy Criteria (MCC), which aims to exhibit better performance than the classical Extended Kalman filter for some types of non-Gaussian noises. The performance of the proposed MCC-EKF SLAM and the classical EKF SLAM are compared by means of numerical simulations.

Vision-Based Object Detection and Localization for Autonomous Airborne Payload Delivery

July,2
18:25
Robotics

James Sewell[1], Theo van Niekerk[1], Russell Phillips[1], Paul Mooney [1]and Riaan Stopforth[2]

[1]Nelson Mandela University, Port Elizabeth, Eastern Cape, South Africa
[2]University of KwaZulu-Natal, Durban, KwaZulu-Natal, South Africa

This paper follows the development of a vision-based object detection and localization system for implementation in an autonomous aircraft for payload delivery. Application of such a system could see use in the delivery of packages to offshore freighter ships and inaccessible inland areas. This system was developed in a modular fashion, such that it could be interchanged and adapted between various airframes. This system comprised of three core elements, namely autonomous flight control, vision-based object detection and localization and payload release and delivery modelling. The final integrated system was tested and was able to achieve fully autonomous flight and was able to model a payload release trajectory from an altitude of 75 m to deliver the given payload with an average displacement of 1.8 m of the designated drop-zone. The drop-zone location was determined via the onboard vision system through the implementation of an object detection and localization algorithm.

July,2
18:45
Robotics

LMI-based Sliding Mode Controller Design for an Uncertain Single-Link Flexible Robot Manipulator

José Manuel Andrade[1] and Christopher Edwards[2]

[1]University of Derby, College of Engineering & Technology, Department of Electronics, Computing and Mathematics, Markeaton St., Derby, DE22 3AW, UK
[2]University of Exeter, College of Engineering, Mathematics and Physical Sciences, North Park Road, Exeter, EX4 4QF, UK

A conventional (first order) sliding mode controller (SMC) is applied to an uncertain planar single-link flexible robot arm in the context of the regulator problem (disturbance rejection). The planar single-link flexible robot arm exhibits nonlinearities and uncertainties associated with Coulomb's friction, the payload, and viscous friction. A SMC design framework that takes into account matched and mismatched uncertainties is proposed in this paper. The design methodology involves linear matrix inequality (LMI) methods and polytopic models of the uncertain planar single-link flexible robot arm. Computer simulation results demonstrate the effectiveness of the proposed sliding mode approach.

July,3
11:05
Nonlinear Data - Theory & Applications III

LSLOCK: A Method to Estimate State Space Model by Spatiotemporal Continuity

Tsuyoshi Ishizone[1] and Kazuyuki Nakamura[1,2]

[1]Meiji University, 4-21-1 Nakano, Nakano-ku, Tokyo, Japan
[2]JST, PRESTO

Model estimation from spatio-temporal data is important topic since it helps us to extract useful information from big data in recent years. In this paper, we introduce an estimation algorithm of the linear Gaussian state space model with focusing on the real-time property. The proposed algorithm uses two key ideas, localization and spatial uniformity, to reduce the number of the parameters. Thanks to this, we obtain stable method to estimate the parameters regarding state transition and states. In addition, the proposed algorithm is quicker and more accurate than existing methods, therefore, it suffices the requirement of the rapid response for the alternation of the fields.

A decentralized strategy for variational collision avoidance on complete Riemannian manifolds

July,3
11:25
Nonlinear Data - Theory &
Applications III

Leonardo J. Colombo[1] and Jacob R. Goodman[1]

[1]Institute of Mathematical Sciences (ICMAT) Calle Nicolás Cabrera 13-15, Campus Cantoblanco, 28049, Madrid, Spain

We introduce a variational approach for decentralized collision avoidance of multiple agents evolving on a Riemannian manifold, and we derive necessary conditions for extremal. The problem consists of finding non-intersecting trajectories of a given number of agents sharing only the information of relative positions with respect to their nearest neighbors, among a set of admissible curves, such that these trajectories are minimizers of an energy functional. The energy functional depends on covariant acceleration and an artificial potential used to prevent collision among the agents. We show the global existence of extrema for the energy functional. We apply the results to the case of agents on a compact and connected Lie group. Simulation results are shown to demonstrate the applicability of the results.

Endpoint Geodesics on the Set of Positive Definite Real Matrices

July,3
11:45
Nonlinear Data - Theory &
Applications III

Maximilian Stegemeyer[1] and Knut Hüper[2]

[1]Max-Planck-Institut für Mathematik in den Naturwissenschaften Leipzig, Germany
[2]Institute for Mathematics, Julius-Maximilians-Universität Würzburg, Germany

In this paper we study the endpoint geodesics problem on the differentiable manifold of real positive definite matrices. The objective is to connect two points given as initial data on that space by a unique geodesic. We first recall partially well known facts about the differential geometry of this manifold. Then we consider further features, namely the property of being an extrinsic symmetric space together with associated Riemannian isometries. This paper is essentially self-contained and therefore accessible to a wide audience.

Accelerated Generalized Correntropy Interior Point Method in Power System State Estimation

July,3
12:05
Nonlinear Data - Theory & Applications III

Hamed Moayyed[1], Diyako Ghaderyan[1], Yassine Boukili[1] and A. Pedro Aguiar[1]

[1]Faculty of Engineering, University of Porto, Porto, Portugal

Classical Weighted Least Squares (WLS) is a well-known and broadly applicable method in many state estimation problems. In power system networks, WLS is particularly used because of its stability and reliability in the cases that measurement noise are Gaussian. Nowadays, with the use of renewable energy sources and the migration to smart grids WLS is no more appropriate because the noises are far from being Gaussian. Recently, a novel state estimation algorithm denoted Generalized Correntropy Interior-Point method (GCIP) was presented that can deal with measurements contaminated by gross errors. In that conditions, the superiority of GCIP is conrmed in a variety of tests. This paper presents an improved GCIP in terms of computational eciency. The main computational burden of GCIP arises from a large dimension matrix of the correction equation. By looking into the structure of the data, a new arrangement for this matrix with lower order is presented that helps to reduce computational time remarkably. The eciency of new method was tested with diferent IEEE benchmark.

Calibration-free HCPV sun tracking strategy

July,3
11:05
Solar Energy and Agriculture

Manuel G. Satué[1], Manuel G. Ortega[1], Fernando Castaño[1], Francisco R. Rubio[1] and José M. Fornés[1]

[1]Escuela Superior de Ingenieros, Universidad de Sevilla, Sevilla, Spain

When using high concentration photovoltaics modules, sun trackers must meet severe specifications in order to keep sun pointing error within a very small angle. Those required specifications are not only mechanical (misalignments in the structure itself, clearances of the joints, etc.) but also regards the installation (misalignments of the platform with respect to geographical north). These uncertainties are error sources that make necessary to calibrate the system after installation and possibly recalibrate it from time to time because of aging. This paper presents a control strategy that avoids the necessity of any kind of calibration by using, indirectly, the produced electric power as feedback. The control strategy is valid as far as the sun tracker is able to perform movements in the azimuth and elevation coordinates independently. Experimental results with a two axes solar tracker are exposed showing the validity of the proposed control strategy under sunny conditions.

Assessment of the nutritional state for olive trees using UAVs

July,3
11:25
Solar Energy and Agriculture

P. Cano Marchal[1], D. Martínez Gila[1], S. Illana Rico[2], J. Gómez Ortega[1], J. Gámez García[1]

[1]Robotics, Automation and Computer Vision Group. University of Jaén, Spain
[2]Integración Sensorial y Robótica, Spain

This work presents the prediction of nutritional state for olive trees based on multispectral information gathered by a camera mounted on an Unmanned Aerial Vehicle (UAV). The results show that this data gathering technique is very promising for this application. The models were constructed using support vector machines for regression with a gaussian kernel and five-fold validation, and provided Mean Absolute Errors (MAE) around 15% for all the nutrients considered, and particularly satisfactory results for N, K, Ca, Mg and B.

CDM Controller Design of a Grid Connected Photovoltaic System

July,3
11:45
Solar Energy and Agriculture

Jo˜ao Paulo Coelho[1], Wojciech Giernacki[2], José Gonçalves[1] and José Boaventura-Cunha[3,4]

[1]Research Centre in Digitalization and Intelligent Robotics (CeDRI), Instituto Politécnico de Bragança, Campus de Santa Apolónia, 5300-253 Bragança, Portugal
[2]Institute of Control and Information Engineering, Poznan University of Technology, ul. Piotrowo 3A, 60-965 Poznan, Poland
[3]Universidade de Trás-os-Montes e Alto Douro, Escola de Ciências e Tecnologia, Vila Real, Portugal
[4]INESC TEC Technology and Science, Campus da FEUP, 4200 - 465 Porto, Portugal

Distributed power sources will become increasingly ubiquitous in the near future. In this power production paradigm photovoltaic conversion systems will play a fundamental role. The crescent tendency of energy price, and an opposed trend for the photovoltaic components price, will lead to a crescent pressure to the installation of this particular renewable energy source in home buildings. In particular on-grid photovoltaic systems where the generated power is injected directly to the main power grid. This strategy requires the use of DC-AC inverters whose output is synchronised in phase with the main grid voltage. In order to provide steady output in the presence of load disturbances the inverter works in closed-loop. This work presents a new way to design an inverter controller by means of the CDM design technique. The obtained results suggest that the controller obtained with this method lead to a robust closed-loop system.

July,3
12:05
Solar Energy and Agriculture

Soiling Monitoring Modelling for Photovoltaic System

Vitor H. Pagani[1,2], Nelson A. Los[1,2], Wellington Maidana[1], Paulo Leitão[1], Marcio M. Casaro[2] and Claudinor B. Nascimento[2]

[1]Research Center in Digitalization and Intelligent Robotics (CeDRI), Instituto Politécnico de Bragança,Campus de Santa Apolónia, 5300-253 Bragança, Portugal
[2]Universidade Tecnológica Federal do Paraná, Campus de Ponta Grossa, PR, Brasil

Soiling on photovoltaic panels is a factor that has a significant impact on photovoltaic production. The monitoring of the soiling index appears as a relevant alternative for maintenance of solar systems. This work proposes a soiling index modelling for photovoltaic systems, based on two input variables: solar radiation and current generated, providing a simple, programmable and reliable way to check the efficiency and establish parameters for cleaning the system. The study performed was based on the adaptation of the modelling, mathematical experimentation of the model presented and the comparison between the system presented with the PVSyst software, for validation of the proposed system. From the validation, was proposed to establish an optimal point for cleaning. Was found that, despite the developed system using only two input variables, it presented a low relative error of 2.07% when compared to the software. From the results obtained, we can conclude that the presented modelling system is valid, and presents excellent reliability, having vast applicability in the monitoring of solar producers of any model or size.

July,3
17:25
Control in Point Vortex Dynamics

The numerical control of the motion of a passive particle in a point vortex flow

Carlos Balsa[1] and Sílvio M. Gama[2]

[1]Research Centre in Digitalization and Intelligent Robotics (CeDRI) - Instituto Politécnico de Bragança, Bragança, Portugal
[2]CMUP - Centro de Matemática da Universidade do Porto, Porto, Portugal

This work reports numerical explorations in the advection of one passive tracer by point vortices living in the unbounded plane. The main objective is to find the energy-optimal displacement of one passive particle (point vortex with zero circulation) surrounded by N point vortices. The direct formulation of the corresponding control problems is presented for the case of $N = 1$, $N = 2$, $N = 3$ and $N = 4$ vortices. The restrictions are due to (i) the ordinary differential equations that govern the displacement of the passive particle around the point vortices, (ii) the available time T to go from the initial position z0 to the final destination zf; and (iii) the maximum absolute value umax that is imposed on the control variables. The resulting optimization problems are solved numerically. The numerical results show the existence of nearly/quasi-optimal control.

Minimum energy control of passive tracers advection in point vortices flow

July,3
17:45
Control in Point Vortex Dynamics

Carlos Balsa[1], Olivier Cots[2], Joseph Gergaud[2] and Boris Wembe[2]

[1]Research Centre in Digitalization and Intelligent Robotics (CeDRI), Instituto Politécnico de Bragança, Campus de Santa Apolónia, 5300-253 Bragança, Portugal
[1]Toulouse Univ. INP-ENSEEIHT-IRIT, UMR CNRS 5505, 2 rue Camichel, 31071 Toulouse, France

In this work we are interested in controlling the displacement of particles in interaction withN-point vortices, in a two-dimensional fluid and neglecting the viscous diffusion. We want to drive a passive particle from an initial point to a final point, both givena priori, in a given finite time, the control being due to the possibility of impulsionin any direction of the plane. For the energy cost, the candidates asminimizers are given by the normal extremals of the Pontryagin Maximum Principle (PMP). The transcription of the PMP gives us a set ofnonlinear equations to solve, the so-called shooting equations. We introduce these shooting equations and present numerical computationsin the cases of N=1,2,3 and 4 point vortices. In the integrable case N=1, we give complete quadratures of the normal extremals.

Passive Particle Dynamics in Viscous Vortex Flow

July,3
18:05
Control in Point Vortex Dynamics

Gil Marques[1], Maria João Rodrigues[1,2] and Sílvio Gama[1,2]

[1]Faculdade de Ciências, Universidade do Porto, Porto, Portugal
[2]Centro de Matemática, Universidade do Porto, Porto, Portugal

We focus on the description of point vortices both in inviscid and viscous environments and try to extend the idea of quantification of chaos in inviscid vortex systems of Babiano et al. to viscous environments. In particular, we notice that viscosity can disrupt stable dynamics and cause initially stable trajectories to go through chaotic behavior, before succumbing to viscosity completely. We also find that the logarithms of the duration of this chaotic behavior and the kinematic viscosity coefficient seem to be connected by a linear relationship. Most approaches to control of point vortices don't take viscosity into account. This should not be what one expects from most real fluids. As such, it is important to take viscosity into account to try to obtain better descriptions and solutions of real world problems.

Optimal route planning in steady planar convective flows

July,3
18:25
Control in Point Vortex Dynamics

Roman Chertovskih[1], Maxim Staritsyn[1], and Fernando Lobo Pereira[1]

[1]Research Center for Systems and Technologies (SYSTEC), Faculdade de Engenharia, Universidade do Porto, Portugal

We consider the following optimal control problem with state constraints: find optimal route between two given points in a planar steady convective flow. The cost function is a weighted sum of the total travelling time and the energy spent by the controller. The optimal control problem is solved numerically by using an indirect method based on Pontryagin's Maximum Principle in the Gamkrelidze's form. Optimal routes are computed and discussed for three examples of convective flows.

Identification and Control of Precalciner in the Cement Plant

July,3
17:25
Modelling

Jakub Osmic[1],Emir Omerdic[2], Edin Imsirovic[2], Tima O. Smajlovic[2] and Edin Omerdic[3]

[1]University of Tuzla, 75000 Tuzla, Bosnia and Herzegovina
[2]Cement Factory Lukavac, 75300 Lukavac, Bosnia and Herzegovina
[3]University of Limerick, Limerick, Ireland

Identification and control of precalciner in the cement production process with the increased use of alternative fuels is presented in this paper. The model of the system consists of the precalciner model as well as of pulverized coal transport model and alternative fuel transport model. The manipulated variable in the precalciner system is pulverized coal, while the alternative fuel calorific value change and the alternative fuel mass flow change are the main disturbances. Outputs of the precalciner model are the precalciner output gas temperature, as a controlled variable, and concentration of CO as measured variable. During the identification process, raw meal mass flow and primary secondary and tertiary air flows are considered to be constant. Based on identified model of the precalciner and the fuel transport model, the mixed logical dynamical controller is designed and implemented at Cement Factory Lukavac (Bosnia and Herzegovina). The mixed logical dynamical controller is realized on the cRIO 9014 real-time controller using LabVIEW (G) programming language. The real-time responses indicate improvements in precalciner temperature control while keeping reasonable low frequency and intensity of CO peaks.

Control of the depth of anesthesia using a new model for the action of propofol and remifentanil on the BIS level

uly,3
17:45
Modelling

Jorge Silva[1], Teresa Mendonça[2] and Paula Rocha[3]

[1]Faculdade de Engenharia da Universidade do Porto (FEUP) and Research Center for Systems and Technologies (SYSTEC), Rua Dr. Roberto Frias, 4200-465 Porto
[2]Faculadade de Ciências da Universidade do Porto (FCUP) and Research Center for Systems and Technologies (SYSTEC), Rua do Campo Alegre, 4169-007 Porto
[3]Faculdade de Engenharia da Universidade do Porto (FEUP) and Research Center for Systems and Technologies (SYSTEC), Rua Dr. Roberto Frias, 4200-465 Porto

This paper presents a simple individualized open-loop con- trol scheme for the automatic delivery of anesthetics in order to achieve and maintain a desired depth of anesthesia. This control scheme is based on a new model for the action of the hypnotic propofol and the analgesic remifentanil, that is more suitable for parameter identification accord- ing to the usual clinical practice. The model parameters are estimated on-line (with a short estimation time), allowing a quick tuning of the controller.

Model of a DC Motor with Worm Gearbox

July,3
18:05
Modelling

Vítor H. Pinto[1,3], José Gonçalves[2] and Paulo Costa[1,3]

[1]FEUP - University of Porto, Faculty of Engineering Porto, Portugal
[2]IPB - Polytechnic Institute of Bragança, Bragança, Portugal
[3]INESC TEC - Institute for Systems and Computer Engineering, Technology and Science, CRIIS - Centre for Robotics in Industry and Intelligent Systems, Porto, Portugal

In this paper, the modeling of a Non-Linear system based on a DC Motor with Worm Gearbox coupled to an Elastic Joint is presented. Worm gearboxes are typically applied when its compactness is an important factor, as well as an orthogonal redirectioning is required. One of the greatest advantages of worm gears is its unique self-locking characteristic. This means that the gear can only rotate by its input side, and cannot be actuated through the load side. Using a DC motor with a worm gearbox is a solution that guarantees that, for instance, i na robotic manipulator, when the arm's joint reaches a desired angle, it does not move until a next required set point. Modeling accurately this system is crucial in order to develop its control in a more efficient way.

Modeling of an Elastic Joint: An Experimental Setup Approach

July,3
18:25
Modelling

Vítor H. Pinto[1,3], José Lima[2], José Gonçalves[2] and Paulo Costa[1,3]

[1]FEUP - University of Porto, Faculty of Engineering Porto, Portugal
[2]IPB - Polytechnic Institute of Bragança, Bragança, Portugal
[3]INESC TEC - Institute for Systems and Computer Engineering, Technology and Science, CRIIS - Centre for Robotics in Industry and Intelligent Systems Porto, Portugal

Throughout this paper it is presented a novel elastic joint configuration, being compared with other similar joints found in recent literature. It is presented its modeling, being its estimation process developed offline, based on a proposed experimental setup. This setup enables to monitor and collect data from an absolute encoder and a load cell. Some data obtained from these sensors is then graphically represented, like angle and torque, obtaining some parameters. Finally, through an optimization process, where the error of the angle is minimized, the remaining parameters of the joint are estimated, thus obtaining a realistic model of the system.

On Control Models in the Motion Stabilization Problem of a Holonomic Mechanical System

July,3
18:45
Modelling

Aleksandr Andreev[1] and Olga Peregudova[1]

[1]Ulyanovsk State University, 42, Leo Tostoi str., Ulyanovsk 432017, Russia

Studies of the motion stabilization problem of a holonomic mechanical system have numerous applications in the design of the control structure of manipulators, wheeled robots, aircraft and other technical objects. For all its great importance and relevance, the problem of substantiating a simpler control structure remains the subject of many works. The paper suggests a new control model that solves the motion stabilization problem. The results are achieved on the basis of the approach and methods previously used by the authors in solving the stabilization problem of given positions and steady-state motions of holonomic mechanical systems.

Conference Statistics

It were submitted 93 papers, being accepted 76, after being evaluated based on a total of 304 reviews. The acceptance ratio of the conference was 82 %;

The Conference has five Plenary Speakers and a MATLAB Course in the last day.

It were accepted six special sessions, with the following themes:

- Nonlinear Data - Theory & Applications
- Control Engineering and Industrial Automation Education
- PID Control : Tuning, Design and Applications
- Control in Robotic Applications
- Control in Point Vortex Dynamics
- Control of Smart Structures

In this year edition lots of diversity can be found, concerning the source of the contributions, some data that shows the dimension of the International involvement can be observed in Table 4. The ideal situation would be to communicate face to face, but due to the current pandemic situation, we were forced to change the conference CONTROLO'2020 to a three day online event.

The proceedings of the conference will be published in the **Springer Lecture Notes on Electrical Engineering** that are indexed by:

- ISI Proceedings
- EI-Compendex
- SCOPUS
- MetaPress
- Springerlink

Country	Authors	Submitted	Accepted	Acceptance rate	PC members
Australia	1	0,33	0,33	1	0
Belgium	4	1,8	0,8	0,44	1
Bosnia and Herzegovina	4	0,8	0,8	1	0
Brazil	9	2,27	2,07	0,91	4
Canada	1	1	1	1	0
Chile	1	0,5	0,5	1	0
China	2	0,67	0,67	1	0
Ecuador	1	0,2	0,2	1	0
France	10	2,42	2,42	1	0
Germany	11	4,33	3,67	0,85	2
Hungary	0	0	0	0	1
India	2	1	0	0	0
Iran	1	0,33	0,33	1	0
Ireland	1	0,2	0,2	1	0
Italy	8	2,4	2,4	1	1
Japan	2	1	1	1	0
Norway	2	1,08	1,08	1	1
Poland	1	0,25	0,25	1	2
Portugal	104	50,6	40,6	0,8	39
Romania	2	0,7	0,7	1	1
Russia	2	1	1	1	0
Slovakia	1	1	1	1	2
Slovenia	1	0,5	0,5	1	0
South Africa	2	1,33	1	0,75	0
Spain	36	10,45	8,65	0,83	13
Sweden	4	1	1	1	1
Turkey	1	1	0	0	2
United Kingdom	7	4,17	3,17	0,76	1
United States	2	0,67	0,67	1	2

Table 4: Statistics per country.

Sponsors

Technical Sponsors

IFAC has accepted to be technical sponsor of the CONTROLO'2020 conference. Having the IFAC seal associated to this event reinforces its relevance in the automatic control landscape.

CeDRI stands for "Research Centre in Digitalization and Intelligent Robotic" and its mission is to contribute to the development, application and transfer of scientific knowledge related to robotics, intelligent systems, and information and communication technologies, in the scope of the digitalization and automation of industrial systems, strengthening the scientific and technological system.

MathWorks needs no introduction and MATLAB is one of the most used numerical computer software in the control area. We appreciate their collaboration in the course that is part of the conference program.

The **SPR** (Portuguese Robotics Society), was founded in April 2006. Their main goals are to foster education, scientific research, technological development and applications (industry and services) of robotic systems.

INSTICC is the Institute for Systems and Technologies of Information, Control and Communication, a scientific, non-profit, association whose main goals are to serve the international scientific community by promoting, developing and disseminating knowledge in the areas of information systems and technologies, control and communications.

Roboplan covers the whole range of robotic applications in the automotive, food, mold and plastic industry or even equipment for the production of renewable energy.

Regular Sponsors

Bragança is a city and municipality in north-eastern Portugal, capital of the district of Bragança, in the Trás-os-Montes region of Portugal. Points of interest in the city include, but not limited to, the *Domus Municipalis*, a beautiful and well preserved castle and a majestic cathedral.

Baixa Hotel is located in the city centre, this simple hotel is a 5-minute walk from local historical exhibitions at the Abade de Baçal Museum, a 9-minute walk from the medieval castle of Bragança.

The **Hotel S. Lázaro** is a modern hotel located near the Iberian Mask and Costume Museum. It has a bar and an international restaurant overlooking the castle.

The **Hotel Tulipa** is located in the center of Bragança, this hotel is located close to the Graça Morais Museum of Contemporary Art and the city's historic castle. It is distinguished by its traditional Portuguese food restaurant.

Author Index